RAY

Relocation of a Portion
Of the Delaware Lackawanna
And Western R. R. Main Line

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RELOCATION OF A PORTION OF THE DELAWARE LACKAWANNA AND WESTERN R. R. MAIN LINE

BY

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I hereby recommend that the thesis prepared under my personal direction by GEORGE JOSEPH RAY entitled Relocation of a Portion of the Delaware Lackawanna and Western R. R. Main Line be approved as fulfilling this part of the requirements for the degree of Civil Engineer.

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Committee on Final Examination.

N O T I C E .

This thesis consists of two volumes: Volume 1, the text; and Volume 2 a box containing 9 profiles in 5 rolls.

RELOCATION OF A PORTION

OF THE

DELAWARE, LACKAWANNA & WESTERN R.R.

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I N T R O D U C T I O N

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Not unlike many of the other railroads built in the early days, the Delaware, Lackawanna and Western was constructed with little regard to alignment and on grades which were too heavy for economic operation with the traffic which is now being handled. The road traverses a more or less broken and hilly country throughout its entire main line from New York to Buffalo. It crosses the Pocono Mountains east of Scranton with a summit of nearly 2000 feet above sea level, dropping into the Lackawanna Valley to an elevation of 735 feet at Scranton, and again ascending to an elevation of 1250 feet at Clarks Summit. The grades each way from Scranton are one and a half percent, uncompensated for curvature. The grade is the same up the east side of the Pocono Mountains.

Considerable improvement has of late been made in the line and grades, and considerable is still possible, but it is practically a physical impossibility to correct the above mentioned grades without greatly lengthening the line and building through an entirely different country. There are parts of the line, however, where the grades can be reduced and at the same time shorten the line and

eliminate curvature. One change of this kind is now under construction between Lake Hopatcong and Slateford, Pa., a distance of 28-1/2 miles by the new line, which will shorten the present line 11.4 miles and greatly reduce the grades.

In this discussion we will confine ourselves to the portion of the line between Scranton and Elmira, which consists of one operating division, both Elmira and Scranton being terminal points.

P R E S E N T   L I N E

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ALIGNMENT,- After ascending from Scranton to Clarks Summit, the line descends to the south branch of the Tunkhannock Creek at LaPlume, crosses the main branch of the same stream at Nicholson, and thence up the east bank of Martins Creek to New Milford Summit; thence down Salt Lake Creek to the Susquehanna River, which it follows to Litchfield, N.Y., thence up the Chemung River to Elmira. A tunnel 2200 feet long takes the line through the ridge between the south and main branches of the Tunkhannock Creek. Practically fifty percent of the line between Clarks Summit and Hallstead is curves, and the majority of the curves are between four and six degrees; the total curvature in this distance of forty-one miles is 3845 degrees.

GRADES,- There is an uncompensated sixty-five foot grade east from the south branch of the Tunkhannock Creek to Clarks Summit, and a thirty-six foot grade westbound from the same point to the tunnel west of Factoryville. Also a sixty-five foot uncompensated grade for four miles from the crossing of the main branch of the Tunkhannock at Nicholson east to Factoryville tunnel, and a twenty-one foot grade westbound for twenty miles to New Milford Summit. There is also a heavy grade eastbound from Hallstead to New Milford Summit, this grade being as much as fifty-five feet per mile near the summit. From Hallstead west to Elmira the controlling grade is 10.56 feet per mile, or two-tenths percent in either direction. Figure 1, page (41) represents a profile of the line, and Figure 6,

page (40) is a small scale location plan.

PRESENT METHOD OF OPERATION

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In discussing the operation of a line it is reasonable to assume that the traffic can be divided into three classes: Passenger, Fast Freight, and Slow or Dead Freight.

Nearly all the passenger trains running on this territory are through trains, and part of them require puller engines eastbound from Nicholson to Clarks Summit. Engines lay up at Scranton and Elmira. (See note) Fast freights are run west from Scranton to Binghamton with single engine tonnage for the grade from LaPlume to the tunnel west of Factoryville. At Binghamton these trains are filled out for Buffalo division tonnage, or for a grade of ten and a half feet per mile in case there is sufficient excess tonnage at that point to so provide. Eastbound, the regular Buffalo Division tonnage is hauled all the way from Elmira to Scranton by using pusher engines from Hallstead to New Milford Summit, and from Nicholson to the tunnel, and from LaPlume to Clarks Summit.

A large percent of the slow freight tonnage is coal which originates in the Scranton district. It is moved westbound, the empties returning east. This coal is handled to Clarks Summit by summit engines operating between the various mining districts and the summit. Single engine trains are run west from Clarks Summit with tonnage for the grade from LaPlume to the tunnel. At

Hallstead these trains are set out to be classified and switched. The engine fires are cleaned, coal and water taken, and the same crew goes on west with a train which has been previously made up, consisting of Buffalo division tonnage. The coal is not billed to destination until it arrives at Hallstead. (Here it should be remembered that anthracite coal consists of a dozen or more different sizes and kinds, and orders from a half dozen different towns may call for as many different sizes on each order.) Hence the necessity for coal being switched into proper order for movement.

The difference in tonnage handled in westbound trains east and west of Hallstead make it necessary to run turnarounds from the Scranton and Kingston districts to Hallstead. Again, all coal going up the Syracuse and Utica divisions is set out at Hallstead from where it is handled by Syracuse and Utica division trains.

In order to handle 4560 M's., or Buffalo division tonnage, between Clarks Summit and Hallstead in either direction, a distance of forty-one miles, it would be necessary to use pushers on all grades, there being two westbound grades with a total pusher distance of twenty-two miles, and three eastbound grades with a total pusher distance of twenty-two miles, one engine additional being necessary on all westbound grades and two or three on all eastbound grades.

CLASS OF POWER USED

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The tonnage which can be handled in either direction by one engine depends, of course, entirely on the class of engine

used. Table No.1, gives most of the engines now in use on the territory in question. In this table will be found the total weight of engines, weight on drivers, and rate of engines in M's.

The first and second class are mostly used for summit runs, and in pusher service. The third class and 3-A class are the engines mostly used in regular freight service on this territory and the Buffalo division, the "3" class engine rating being 4560 M's. The thousand class, shown in class 3-A are passenger engines.

In table No.2, will be found some engine rating curves. These curves were formed by plotting the grade in feet per mile horizontally and the M's. handled vertically. They are not theoretical values, but are plotted from actual grades where the engines are at present or have in the past handled the tonnage shown. From these curves it is very easy to arrive at the correct grade for any given engine and tonnage to be handled, or the class of engine can be found when the grade and tonnage are known.

APPROXIMATE TONNAGE

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The net tons of coal and freight handled, also the number of passengers carried for the past ten years on the Lackawanna is shown in Table No.3. This table also shows the increase or decrease from year to year, as well as the percent of increase or decrease, and the average for the period considered

PHYSICAL IMPROVEMENTS TO BE AFFECTED BY RELOCATION

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It is evident that the part of the line between Scranton and Hallstead is an expensive line to operate and maintain. Besides the bad grades and curves heretofore described, there are at present 29 grade crossings of public highways, all of which will some day have to be abolished at considerable expense. The bridges are all in good shape and have recently been rebuilt, with the exception of one four-span deck truss bridge over the main branch of the Tunkhannock at Nicholson. This bridge will have to be rebuilt unless the line is changed within the next five years, and as it is sixty feet high and 420 feet long, it will be an expensive job.

The lay of the country is such that it is impossible to get a lower summit than the present one at Clarks Summit, and the grade between Scranton and the former point cannot be reduced. It therefore remains to be seen what can be accomplished from Clarks Summit west; (first) by reducing gradient for both east and westbound tracks; (second) by reducing maximum degree of curve and total curvature; (third) by eliminating distance; and (fourth) by eliminating rise and fall.

RECONNOISSANCE OF POSSIBLE LINES

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The small location map, Figure 6, on page (40) shows the watersheds in a part of Lackawanna, Wyoming and Susquehanna Counties, Pennsylvania, and the adjoining part of the state of New

York. The present line is shown in white, and extends nearly north through Lackawanna, Wyoming and Susquehanna Counties to the Susquehanna River, New York State, and thence west to Elmira. The south and east part of Susquehanna County and all that portion of Lackawanna and Wyoming Counties through which the line runs, is drained by the Tunkhannock Creek, and its branches. The northern half of Susquehanna County is drained to the north by the Susquehanna River. The southwest portion of Susquehanna County and easterly portion of Bradford County are drained to the south and southwest by the Susquehanna River, through the Wyalusing and numerous other creeks. The extreme northeast part of Bradford County is drained to the northwest by the same river, through the Wappassening Creek, thus we find a high divide extending nearly east and west across the center of Susquehanna County into the northeast part of Bradford County.

The various creeks above referred to have cut their way through the rocks until their beds are now from three to seven hundred feet below the surrounding hills and divide above referred to, the general direction of these streams being at right angles to that of the line. It is an impossibility to locate a new line which would be a radical improvement as to curves, line, etc., without encountering very heavy construction.

Government topographical maps have not been made for any of the territory in question north or west of Nicholson, and as no reliable elevations could be secured, excepting in the vicinity of the present tracks, it was necessary to do most of the reconnoissance work by means of an aneroid barometer. Levels were taken by a level party in the highways, and many miles were covered with the Locke level.

Prior to starting a reconnoissance survey for correction of line it is quite necessary to determine the approximate grades to be followed, and in the case at hand this was done as follows:

From Table No.1, and the curves on Table No.2, it is seen that a class 3 or class 3-A engine with a class 1 or 2 pusher would easily handle full Buffalo division tonnage on a 36 foot grade. Therefore, in order to reconstruct the line for single engine trains or two engine trains and keep the tonnage the same as at present between Hallstead and Elmira, we must make the grade not to exceed ten and a half feet per mile for single engines, or not to exceed thirty-six feet per mile for two engine trains.

In figuring on the grades a compensation for curvature of three hundredths of one percent was allowed per degree on all curves. This amount was decided upon after a series of dynamometer car tests made in the following manner.

A change of line was decided upon a few miles east of Scranton in 1906. This covered about five miles of very crooked alignment, with numerous six degree curves on a grade a little in excess of 1%. The new line was constructed with a maximum curve of two degrees and on account of materially shortening the distance and the limitation of construction it was necessary to carefully figure the grade in order not to have it in excess of the grade on the old alignment. An allowance of three one hundredths of one percent in grade was made per degree of curve. Dynamometer car tests were made with various engines on the old alignment prior to the change. After the alignment was completed dynamometer car tests were again made on the new line. By careful comparison of the tests made before and

after the change of alignment, and carefully considering all points entering into the problem, it was found that three hundredths was about the correct amount to allow.

With these grades in mind, and with the assistance of county maps, on which the public highways and streams were roughly located, the entire country was carefully covered. It was then concluded that the preliminary lines would have to be run along three or four different possible routes in order to make sure which one would be the best one on which to locate.

PRELIMINARY SURVEYS

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As previously stated, the country under consideration is very rough and irregular. Throughout the greater portion, and especially that part lying between Factoryville, Pa., and Nichols, N.Y., no government contour maps have ever been made, and in fact no information was available relative to elevation.

After an approximate location had been selected, a level party of two men preceded the main party. They followed the general direction of the reconnoissance line and established accurate bench marks on the line of the proposed survey.

The preliminary surveys were made by stadia. This was decided to be the best method on account of it being possible to proceed faster and a smaller party being necessary to carry on the work than would ordinarily be required under the usual method. The party consisted of Chief of Party, Topographer, Transitman, Notekeeper, 3 Rodmen, a Cook, and a Driver, or a total of nine men. Two

covered wagons were used, one for the sleeping quarters for the men, and the other for cooking outfits, drafting table, etc. It was necessary to make such provision on account of the sparsely settled condition of the country. A Berger transit with vertical arc and stadia hairs was used for the survey. A topography board 27" square with a waterproof pocket on the back for carrying maps and drawing instruments, three twelve foot stadia rods, and a Kueffel & Esser stadia slide rule, made up a part of the equipment.

It was first planned to run a base line and take the topography at the same time, but it was found somewhat difficult to keep up the map work without holding back the rest of the force. It was also found hard to plot these maps in the strong sunlight or in case of rainy weather. Again, a mistake in calculating a turning point could not be checked, on account of lack of time, until after considerable topography had been plotted, and this would, perhaps, necessitate the re-plotting of a whole sheet. It was, therefore, decided to first run out the base line, the topography being taken secondly, and notes being plotted out in camp or in the office. In plotting notes a semi-circular protractor graduated to thirty minutes was used. This protractor was also graduated along its diameter so that by drawing the north line through the point from which the topography locations were made and placing the zero of the protractor at this point, the topography could be plotted quickly by noting the bearing and distance of the object.

All deflection angles on the base line were checked by the needle bearings. The note-keeper reduced the readings on the transit line in the field with a slide rule, and figured the elevation and distance of each transit point so as to keep as close as

possible to grade, the grade line having been previously roughly determined. The elevations as run by stadia were checked on the bench marks, which had been previously set, and it was found that they usually checked within a foot. The preliminary location was made on contour maps and the preliminary estimate of yardage was worked up from the center line elevation shown by the contour map. The ground on which the line was located was side hill slopes which varied from a two to one to level ground. The quantities of cut or fill on side hill slopes, where the slope is steeper than five to one, increase considerable over that on level ground, and this was taken into consideration in figuring the quantities. Where some of the work was checked with the regular cross section work it was found that the quantities were within 2% of being correct.

The cost of making this survey was about $45.00 per mile, which cost includes all work in the field, making the maps, and cost of provisions, and supplies. The average distance covered was two miles per day, and camp was generally moved about every seven days.

DESCRIPTION OF PRELIMINARY LINES

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As previously stated, four preliminary lines were run; these lines are all shown on the small map, Figure 6, om page (40).

SHORT LINE,- This line is shown in yellow on the maps and is the first one run. It provides for a change of line from Clarks Summit to Foster, four short corrections for two tracks along the present line and on the same grade from Foster to New Milford Summit, three tracks from New Milford Summit to New Milford Station

and four tracks from New Milford to Hallstead. The present two tracks with slight changes in grade to become the westbound tracks between the last two points, the two new tracks being constructed on a thirty-two foot grade westbound. Three tracks were figured for the line between Nicholson and Clarks Summit, which is on a 36' grade eastbound.

A profile will be found in Volume two on which is shown the alignment, grades, cuts and fills, disposition of materials, length of haul, road crossings, waterways, &c. The quantities given for cuts and fills as well as the amount of masonry shown is for a double track line. In the estimates, however, these quantities were increased for three tracks. This profile does not extend past Foster as the grade from Foster to New Milford is not materially changed, and from New Milford to Hallstead the line is the same as the Martins Creek line, shown on profile in Volume two.

This line would require one engine pusher service from Hallstead to New Milford Summit and Nicholson to Clarks Summit east bound, as well as from Nicholson to New Milford Summit westbound. The alignment from Clarks Summit to Foster would be good, and in fact better than any other of the lines run for an equal distance from Clarks Summit. From Foster west to New Milford the alignment would not be so good, owing to the crookedness of Martins Creek, the height of the adjoining hills and the present line being so little above the elevation of Martins Creek.

As shown on the profile, a tunnel 6000 feet long would be necessary four miles east of Nicholson, as well as a short tunnel just east of Foster. The former would be on a 36' grade eastbound, and provision would have to be made for one or two open

cuts each 100' in length for ventilation. It would be possible to eliminate the short tunnel by introducing a little more curvature and slightly adding to the cost. This may be advisable and can be definitely settled when final location is run.

The distance would be reduced by 3.4 miles, and the total curvature by 2459 degrees, one four degree curve would be necessary just west of the long tunnel, and a long 3 degree curve just east of Nicholson, would be the only curves over two degrees. The construction work would not be unusually heavy excepting one viaduct which would be constructed across the main branch of the Tunkhannock Creek at Nicholson. If borrow could be secured it would probably be cheaper to construct two small arches and fill instead of constructing viaduct.

THE TUNKHANNOCK LINE,- The Tunkhannock line is shown in green on the map, and is a high grade line run with the idea of avoiding pusher grades either east or west between Clarks Summit and New Milford Summit, and hence had to be kept far to the east of the present line in an entirely new country; from New Milford to Hallstead the line is approximately the same as the Short Line. The total length of construction would be 37.4 miles, and the distance would be shortened by 4.7 miles, 2442 degrees of curvature would be eliminated, and all curves would be 2 degrees and under excepting three, three degree curves, one at Clarks Summit, one at the east end of the New Milford tunnel, and one just west of New Milford.

A profile of the line will be found in Volume two. All quantities were figured for two tracks with passing tracks both east and west between Clarks Summit and New Milford, with three tracks from New Milford to Hallstead.

The line crosses the south, east, and main branches of the Tunkhannock Creek, and on account of these streams running across the general direction of the line, such a location would require some very heavy work. The south branch would have to be crossed on a viaduct 172' high, the east branch on one 280' high, and the main branch would have to be crossed at a height of 344'. Approaching the latter crossing from the east would be a tunnel 2790' long, and it would also be necessary to drive a 1200' tunnel just west of the east branch crossing. About nine miles east of Clarks Summit the grade line passes under Crooked Pond, a small natural lake about 60' deep, which would have to be purchased and drained. The worst problem of the entire line would be a tunnel 7800' long, which would be required to get across the divide between the Tunkhannock and the Salt Lake Creek watersheds east of New Milford. This tunnel would be on a 10-1/2' grade eastbound, and west of the tunnel the track would drop down on a 36' grade to Hallstead.

NICHOLS LINE,- The most westerly line on the map, and shown in brown, is called the Nichols Line. This line was projected primarily on account of the great amount of distance which could be eliminated. The total length of the line as run is 60 miles, and the distance eliminated would be 27 miles. All told 2933 degrees of curvature would be eliminated, and the maximum degree of curve would be 3 degrees, there only being 7 curves over 2 degrees.

In Volume two will be found a profile of the Nichols Line from which will be seen that it was figured as a two track line. Passing tracks are provided in either direction at points where they would be the most servicable. For the first 3-1/2 miles out of Clarks Summit the line is practically the same as the Short Line.

It then swings to the left, crossing over the present line west of Factoryville, running in a northwesterly direction intersecting the main line west of Nichols.

Going west from Clarks Summit, the first unusual heavy work would be the viaduct to cross the south branch of Tunkhannock Creek, which would have a maximum height of 160'. At station No.305 a viaduct would be required on account of the height of the crossing and good borrow not being available. The main branch of the Tunkhannock Creek would be crossed on a viaduct about 275' high, having a length of nearly 2000'. In a similar manner it would be necessary to cross White Creek, the north, middle and main branches of the Wyalusing on long and high viaducts, all as shown on the profile above referred to. It will also be seen that five tunnels would be necessary varying from 1030' to 4750' in length.

MARTINS CREEK LINE,- This line shown in red in the map runs west from Clarks Summit to Nicholson on approximately the same location as the Short Line, and on a 35' grade to a point about four miles east of Nicholson, thence down to Nicholson on a 10-1/2' grade; thence west up to New Milford Summit on a 10-1/2' grade, thus avoiding westbound pushers. From New Milford Summit to Hallstead this line is the same as the Short Line.

A profile will be found in Volume two. This profile shows but two tracks from Nicholson to New Milford Summit; estimates however, have been based on three tracks from Clarks Summit to New Milford Summit, with two new tracks from New Milford to Hallstead, and three tracks from New Milford Summit to New Milford. The length of the line would be 35.8 miles and would shorten the distance by 3.6 miles, eliminate 2179 degrees of curvature, and the

maximum curve would be three degrees, with very few curves exceeding two degrees. The heaviest construction would be one high and long viaduct at Nicholson, and two large fills, one across the south branch of Tunkhannock Creek, and one across Martins Creek, both exceeding 1,500,000 yards; also one tunnel 2955' long. By crossing the Tunkhannock Creek at Nicholson as high as possible, the grade west to New Milford Summit could not only be reduced but the present alignment, which is very bad, can be greatly improved.

COMPARISON OF PRELIMINARY LINES

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Tables No.5, and No.6, give a comparison of the four different preliminary lines heretofore considered. It will be noted that the Short Line requires 23.8 miles of new work, the Martins Creek Line requires 35.8 miles, the Tunkhannock Line 37.7 miles, the Nichols Line 60 miles.

Table No.5, shows the total distance eliminated for each line, the total degrees of curvature eliminated, and the total reduction of rise and fall.

Table No.6, gives the total yardage (both earth and rock) the amount of waste and borrow, length and amount of tunnel excavation, the amount of concrete required, etc.

From Table No.6, it will also be noted that the total cost of constructing the Short Line is estimated at $7,614,691.00, the Tunkhannock Line at $10,516,073.58, the Nichols Line $28,092,602.21, the Martins Creek Line $11,146,602.75.

There would be a considerable credit allowable on each of the above lines, all of which is shown in Table No.5, and which is

made up of the following items:

Third track (wherever the same is figured) public grade crossings on the present line, which would otherwise have to be eliminated, the cost of reconstructing the present bridge at Nicholson, relaying rail, which would be relieved, other track fixtures, scrap, right of way, etc.

It will also be noticed that with the Short Line, Tunkhannock Line, or Martins Creek Line, a credit is given of $29,449.30 on account of Hallstead Yard. This amount represents one-half the annual savings on account of doing away with the present yard at Hallstead by the construction of a hump yard near Scranton on the Keyser Valley branch. It is figured that with the change of line it will be possible to do the switching in the new hump yard and handle trains through from Scranton to Elmira, Binghamton and Syracuse, thuse annually saving the amount above referred to on account of the present cost of operating the yard at Hallstead.

Table No.5, also shows the saving due to reduction of grade, elimination of distance, curvature, rise and fall, all of which will be fully discussed later on.

PROBABLE SAVING TO BE EXPECTED IN OPERATION AND MAINTENANCE DUE TO REDUCTION OF DISTANCE, ELIMINATION OF CURVATURE, RISE AND FALL, AND REDUCTION OF GRADIENT...........

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Now that we have determined the approximate cost of the various lines under consideration, and have fairly accurate details on the grades, length of line, curvature, rise and fall, etc., we are in a position to proceed with the estimate of the annual

saving to be expected if the line were rebuilt as per any of the preliminary lines run.

In going into the question of savings in operation to be effected it would be of great assistance if it were possible to secure accurate data showing the amount actually saved in operation and maintenance, because of improvement in line and grade. Unfortunately no such data is available. In the few cases where important improvements have been made the natural increase in business, together with other changed conditions of operating, make a comparison of the figures practically useless. The tractive power of engines has been continually on the increase, the average car capacity is continually increasing, and business in general increases from year to year. New passing tracks, interlocking stations, and signal systems, additional legislation and government regulation changes the operating conditions so much from year to year that it is a very hard matter to make a fair comparison one year with another.

Furthermore, the conditions on different railroads vary so much that it is nearly impossible to compare one road with another, therefore it becomes necessary to deal with each problem, of the kind under consideration, in an independent way, being governed by the conditions at hand.

The first and second columns of Table No.4, were taken from the Annual Report of 1908. The first column represents all items entering into the Maintenance and Operating accounts. The second column represents the gross amount of such items. The third column represents the percent each separate item bears to the whole, i.e., to a total of $17,973,138.82.

From the same report we find that the total passenger and

freight train mileage was 12,516,839 miles, hence the actual cost per train mile was $1.436 ~~cents~~. In figuring the total train mileage the work-train mileage has not been included, but the cost of these work-trains is included in the total cost of operation and maintenance. It will be readily seen that this item greatly increases the expense per train mile. The Lackawanna Railroad averages about twenty work-trains per day, six days in the week, the year around. This is an average of one train for each fifty miles of line operated. In similar calculation work-train mileage is generally included in total train mileage and the cost per train mile figured out accordingly. I contend that this would not be correct in the case at hand. In the first place, work-train expense is wholly on account of Maintenance and Construction. After improvements in line and grade have been made the amount of work-train service will in all probability be materially reduced. The cost of operating the work-train, however, will be practically the same as it is at present. It will increase proportionately to the increase in labor and cost of material. It will decrease to some extent on account of the decrease in curvature, grades, etc., reducing wear and tear on equipment and roadbed. Any reduction in grade or length of line which tends to increase the amount of work which can be done by a work-train will tend to reduce the number of work-train days, but will, in a like proportion increase the cost of maintaining work cars for a given train, because of the greater number used in the train. Again, on account of the new line being constructed in an up-to-date manner with all permanent structures, standard ballast, and heavy rail, work-train service will be greatly reduced.

If a reduction in grade is made which will enable an engine

to pull a heavier train, and thus reduce the number of train miles over the territory in question, we must arrive at the probable saving due to the elimination of one train. In like manner, the reduction of one mile in distance will eliminate one train mile on every train run, and hence we must arrive at the probable saving due to the elimination of one mile in distance. Again, if the grade is reduced so as to reduce the number of pusher engines required, we must arrive at the probable saving due to eliminating one pusher mile.

GRADES,- When an improvement in the grade is made such that a given engine will be able to handle an increased tonnage over a division, it is evident that there will be a saving in the expense of operation. This change may not be enough to enable the total tonnage to be handled with any fewer number of trains. In such a case, the saving would be small and would only consist of a decreased amount of fuel consumed, a slight decrease in the cost of maintaining roadbed and equipment, and also a decrease of over time paid the crews. Where a division is so long that it is hard for a freight train to get over it in sixteen hours even when making ten miles per hour any slight improvement in grade that would help the speed of trains would be of value to the road as a help in keeping within the law but would have no money value, or at least very little as it would have no affect on wages of train crews. On the other hand, on a division so congested, or where operating conditions were so bad that freight trains could not make ten miles per hour, a slight grade reduction that would speed up trains would have a direct value in reducing the wages paid train crews, that is reducing overtime, no matter what the length of the division. When

a train makes ten miles or more an hour the crew is paid for the actual miles they make, but if a train makes less than ten miles per hour the company pays the crew for ten miles anyway, and overtime is the difference between the ten miles that the company pays for an the number of miles that the train actually runs. The element of time becomes more important as the traffic increases, the present sixteen hour law making it necessary to get crews over the road within the stated period.

A division may have one controlling grade over which it is necessary to use pusher engines to assist engines handling the full tonnage for the remainder of the division. The elimination of such a grade would reduce the operating expenses by eliminating the pusher engine, i.e., by the amount of wages paid the crew, interest charge, and cost of maintaining the engine, and track appliances affected by the operation of the pusher engine. Again, a grade revision may so alter the grades as to make it possible to reduce the number of trains run in one or both directions, thus saving the expense of operating a number of engines, wages of crews, maintenance of track, etc.

We will assume that the grade can be reduced sufficient to eliminate one train per day, and proceed to calculate the amount this saving will affect the cost of maintenance and operation. It is plain that the amount saved will depend on the mileage over which this train would have to operate if run, and hence it will be necessary to reduce all figures to train miles.

In column No.4, Table No.4, is indicated the percent of each item affected by addition or elimination of one train to handle a given business. I will take each item up in order, and dis-

cuss the reason for the percentages as fixed in the first half of Column four.

Item No.1, (Superintendence) Item No.1, will not be affected in any of the calculation entering into this table, and will not be further considered.

Item No.2, (Ballast) Allowed 20%, for reason that ballast is affected by age, wear, ashes dropping from fire boxes, fine coal dropping or being thrown from the tenders, and oil and waste from engines and cars. The elimination of one train eliminates the wear and drippings from one engine and tender.

Item No.3, (Ties) 20% affected. Engines cut ties out, and also spread track much worse than cars. The mechanical life of a tie is greatly affected by the engine. Hot cinders and coal assist in the destruction of ties. The use of tie plates and screw spikes will assist greatly in lengthening the life of the ties, but the cost of keeping them up will depend upon the number of engines passing over the track and the physical life of the tie is shortened as the number of engines passing over it increases.

Item No.4, (Rails) 50% affected on the assumption that engines produce one-half of all rail wear.

Item No.5, (Other Track Materials) This is placed at 20% on the ground that spikes, tie plates, angle bars, etc., will be affected about the same amount as ballast and ties.

Item No.9, (Work-train Service) This is placed at 37% it being affected somewhat more than ballast and somewhat less than rail.

Item No.17, (Interlocking) Approximately 37% of this item would be affected by the number of train movements, while the other 63% would not be so affected. It is probable that a larger percent

of the road plants would be affected by train movements. On the other hand the terminal plants would be less affected.

Item No.18, (Signals) 60% is allowed on the ground that about this proportion of the expense would be affected directly in proportion to the number of train movements. The life of an automatic signal depends on the use it receives and the efficiency of its maintenance. The cost of maintenance increases with the number of train movements and as the train movements increase the distance between signals must decrease.

Item No.20, (Telegraph & Telephone Lines) 10% affected, on the assumption that less telephone and telegraph stations are necessary.

Item No.27, (Roadway Tools & Supplies) 37% affected, or the same as work-train service.

Item No.28, (Injuries to Persons) 100% affected, on account of being directly proportion to train movements.

Items Nos.34,35,36, (Steam Locomotive repairs, renewals and depreciation) Allowed 62%, this being the percentage that the freight locomotives, plus the passenger and milk pullers and pushers, bear to the total of all locomotives. It should be stated at this time that for the part of the road under consideration pullers and pushers are now necessary on heavy passenger and milk trains and these will be eliminated and are considered under the head of "Helpers" in the table now under consideration.

Items Nos.43,44,45, (Work equipment, repairs, renewals and depreciation) Allowed 25% on the basis that it would be considerably lower than the percentage allowed on Item No.9, or work-train service, for the reason that a large part of the work which re-

quires work equipment will be independent of the number of trains run.

Item No.46,47,48, (Repairs and Renewals of shop machinery and tools and Injuries to Persons) Allowed 30% which equals the percent that 62% of the cost of engine repairs and renewals plus 25% of the cost of work equipment, repairs and renewals, bears to the total cost of maintenance of all equipment.

Item No.61, (Dispatching Trains) Allowed 25% on the basis that there will be no reduction in the number of dispatchers, but 50% reduction in the office force.

Items No.78,79,80 (Road Enginemen & Enginehouse Expenses (Road) Fuel for Locomotives) 100% allowed, as all these items would be eliminated.

Item No.81 (Water for Road Locomotives) Allowed 60% on the basis that the number of water stations would not be affected, but that the payment for water and the wages of pump runners, coal consumed in pumping water, etc., would be affected 100%.

Items No.82,83,84, (Lubrication, Other Supplies for Road Locomotives and Road Trains) All affected 100%.

Item No.92, (Other Expenses) Allowed 75%, being an average of the allowance made on the other items.

Item No.101, (Loss and Damage-Freight) Allowed 15% on the ground that 75% of such loss is due to trains on the road, 20% of damage on road due to engines.

All items not considered above would not be affected by the elimination or addition of one train. The percentages above given multiplied by the percent that each item is of the whole gives the last figures under Column No.4. The sum of these latter items or

33.63% gives the percentage of the total actual cost per train mile that would be saved by a grade reduction such that any given business could be handled by one less train. This percentage, 33.63%, multiplied by $1.436, or the actual cost of moving a train one mile, gives the actual money that would be saved by every train mile thus eliminated in the handling of a given business.

There would be an interest charge to be added to the above figures on account of eliminating the locomotive, which would amount to 1.22 cents per train mile, making the total in saving or increase in cents per train mile for one less or one additional train of 48.51 cents.

DISTANCE,- It will be readily seen that the effect of eliminating distance on the expense of operation and maintenance, depends on the length of line eliminated. From Table No.5, it will be seen that the minimum distance eliminated where all traffic is affected is 3.6 miles for the Short Line. By the Nichols Line the distance between New York and Buffalo would be reduced 27 miles, but it would still be necessary to maintain the present line between Factoryville and Binghamton in order to take care of the local business between these points, as well as that of the Syracuse and Utica Divisions. For the letter reason the Nichols line will have to be given special consideration. Therefore, for the present we will consider that the distance eliminated will be sufficient to affect Maintenance of Roadbed and Equipment, Train Wages, Fuel, Train Supplies, etc.

In all cases under consideration, the number of stations and station employes will not be reduced and with the Nichols Line three or four new stations would probably be required. The latter, however, would be fully supported by new business, and, therefore,

need not be taken into consideration.

In Column No.5, Table No.4, will be found the percent of the various items making up Operating and Maintenance Expenses affected by the elimination of distance as explained above.

All of the following items would be eliminated, and hence 100% should be allowed.

Item No.2 (Ballast), No.3 (Ties), No.4 (Rail), No.5 (Other Track Materials), No.6 (Controlling & Watching), No.7 (Bank Protection), No.9 (Work-train Service), No.10 (Other Expenses), No.11 (Removal of Snow & Ice), No.13 (Bridges & Culverts), No.14 (Over & Under Crossings), No.15 (Crossings,Fences & Signs), No.16 (Snow Sheds & Fences), No.17 (Interlocking Plants), No.18 (Signals), No.27 (Roadway Tools & Supplies), No.28 (Injury to Persons), No.78 (Road Enginemen), No.79 (Enginehouse Expenses-Road), No.80 (Fuel for Road Locomotives), No.81 (Water for Road Locomotives), No.82 (Lubrication for Road Locomotives), No.83 (Other Supplies for Road Locomotives), No.84 (Road Trainmen), No.93 (Interlocking Blocks & Signals), No.94 (Crossing Flagmen & Gatemen).

Item No.20 (Telegraph & Telephone Lines) 75% affected. This would be 100% except that there is no change in the number of offices.

Item No.34,35,36 (Steam Locomotive Repairs, Renewals & Depreciation) Allowed 80% for the reason that 80% of all engines are in road service.

Item No.37, - 47, inclusive (Passenger Car Repairs, Renewals & Depreciation - Freight Car Repairs, Renewals & Depreciation - Work Equipment Repairs, Renewals & Depreciation - Shop Machinery Repairs & Renewals) All affected 75% on the ground that 75% of these repairs are made necessary by their own movement. This may be a

little high for freight cars on account of their being considerably damaged in yards. It is, however, in all probability low for passenger cars.

Item No.86,87 (Heating & Lighting Cars) 30% affected, this would be more, except for the reason that a great many passenger cars are in suburban service where the cost of lighting per train mile is greater than in through trains. Again, a part of the expense of heating and lighting is cost of plant and the maintenance of same at the Terminal which would not be materially affected.

Item No.88, (Lubricating Cars) 80% affected.

Item No.101, (Loss & Damage-Freight) 75% affected, 25% being due to damage in Terminals and Yards.

Following the same method explained under Eliminating Grade, we find that the total saving in cents per train mile on account of eliminating one mile in distance is 91.55 cents.

HELPER ENGINES,- In changing the grade so as to increase the amount of tonnage one engine can handle, the total pusher mileage may be increased or it may be decreased. It is therefore necessary to calculate the expense per mile for an additional pusher engine.

The figures in Column No.6, Table No.5 , represents the percent of maintenance and operating expenses affected by the addition of one pusher engine. Assuming that 50% of the pusher engine mileage is light, the item of Maintenance of Roadbed and Equipment would be at least affected 50% as much as in case of reduction in grade, as given in Column No.3. Considering that the light engine would do one-half as much damage to track and itself as the engine handling tonnage, the items affected would therefore be affected about 75% as much as that allowed for reduction in

grade, and they have been so arranged in Column No.6.

Item No.78 - 83 (Road Engine, Enginehouse Expenses-Road)(Fuel, Water & Lubrication for Road Locomotives, and Other Supplies) would be affected the same as in the case of grade.

Item No.84 (Road Trainmen) would be affected about 33% on account of two-thirds of crew not being necessary on helper engines.

Item No.105 (Injury to Persons) is 10% affected.

Thus we find the saving in cents per pusher mile saved is 39.93.

CURVATURE,- In order to arrive at a fair value which we can place on the elimination of curvature, it is quite necessary to depend on experience and the conditions at hand. In a general way the amount of rail wear on curves on any given territory depends upon the total curvature and not so much on the degree of the curves. This is also true of most of the other items of expense affected by elimination of curvature. Therefore, in calculating the saving due to reduction of curvature it is most convenient to consider the total degrees of central angle eliminated. The value of reducing the degree of curves will be later considered, since this cannot be reduced to a monetary basis.

The total amount of curvature on the Lackawanna Railroad is sufficient to make an average of about 50 minutes per mile for the entire line. Over certain parts of the road and especially the territory under consideration there are many five and six degree curves. Careful observation covering a term of years goes to show that it is very much harder and more expensive to maintain track on a sharp curve than it is on straight track. Curved track is also much harder on equipment and greatly adds to train resistance. The

amount of the latter has heretofore been discussed, and need not be considered in connection with the present discussion. The new lines have not been laid out on theoretical grades for a given tonnage, but for a tonnage which it is known can be handled. Any gain made in tonnage on account of reduction in the degree of curvature has been considered in making up the tables showing the reduced number of trains necessary to handle the tonnage on account of reduction of grade.

In order to estimate the saving to be expected by reduction in curvature, a comparison is made between a mile of five degree curve and a mile of track having our average alignment. The comparison is actually made between a five degree curve and straight track, and allowance made for the average curvature.

The Maintenance and Operating Expenses given in the second column of Table No.5, represents the average condition, i.e., an alignment of approximately (0) degrees and (50) minutes. In column seven, Table No.5, I have assigned percentages for the items affected, and will give below the reason for choosing the figures shown.

Item No.2 (Ballast) 50% allowed owing to the increased quantity of ballast necessary on curves, more being required to form the shoulder and provide for elevation. There is greater wear on the ballast and consequently shorter life on account of the necessary additional tamping.

Item No.3 (Ties) Allowed 50%. The average cost of ties on straight track is about 25% lower than on curved track, and the life of the tie on straight track is at least 30% more than on five degree curve track.

Item No.4 (Rail) Allowed 400%. Based on the rail renewal records of the road covering the past seven years. There are curves

where this percent would be too high, and on others it would be too low. We have curves ranging from five to seven degrees on which 100 pound Bessemer Rail will not last to exceed nine months, and the life of Open Hearth Rail is not to exceed fifteen months. Old rail which was laid from twelve to sixteen years ago is still in use on straight track, taking the same traffic. The wear of rails depends greatly upon the location of the curve. Where a curve is located on a heavy down grade the wear on rails is very much increased due to the braking of trains to prevent excessive speed. If a curve is elevated for the fast trains, and slow trains use the same track the low rail gets excessive wear due to taking the greater part of the axle loads. In making the comparison it is necessary to compare average conditions.

Item No.5 (Other Track Materials) Allowed 300%, for the reason that angle bars and bolts have to be changed with the rail and more are broken in curve track. More substantial spiking is also necessary and heavy tie plates are necessary.

Item No.34,35,36 (Locomotive Repairs, Renewals & Depreciation) 30% on the basis that at least 15% of engine repair and renewals is chargeable to drivers and tires, and the expense will be at least three times as much on a five degree curve.

Item No.37-45 (Passenger Car Repairs, Renewals and Depreciation - Freight Car Repairs, Renewals & Depreciation - Work Equipment, Repairs, Renewals & Depreciation) All 30% affected.

Items No.36, 47 (Repairs & Renewals of Shop Machinery & Tools) 30% affected.

Item No.80,82 (Fuel & Lubrication for Road Locomotives) will be affected approximately 25% on account of increased train resist-

ance and hence additional coal and lubrication necessary. The resistance on a five degree curve would be about equal to a thirteen hundredth percent grade on a fifty minute curve, or approximately one quarter of the grade which alone produces the same train resistance as that of a train being handled on straight and level track, i.e., 10 pounds per ton.

Item No.93 (Interlocking Blocks, Signals, etc.) will be affected about 25% on account of the necessity of shorter blocks.

Item No.101, (Loss and Damage-Freight) 10% affected on account of derailed cars caused by improper loading, worn flanges and worn rails, or defective track on curves.

RISE AND FALL,- It is evident that the elimination of rise and fall will, at least to a limited extent, reduce the cost of operating a given train over the road. It is generally considered that the average train resistance is 10 pounds per ton of train on straight and level track. The resistance on a five tenths percent grade would, therefore be 20 pounds per ton, 10 pounds due to grade and 10 pounds due to friction, etc. In other words, the resistance on a five tenths percent grade is double what it is on level track. Therefore, if we have two miles of level tangent track and two miles of tangent track with a 26.4 foot hump in the middle, a train will have to overcome the same resistance in climbing one mile to the hump as it would to run the two miles on level track. It is easy to see that it would cost something to handle the train from the hump down the five tenths percent grade for a mile even though the grade is sufficient to enable the train to coast down by gravity and not steep enough to make it necessary to apply breaks. The 26.4 feet of rise and 26.4 feet of fall is called 26.4 feet of rise

and fall, and in Column No.8, Table No.5, is given the percent of items affected by the operation of the two miles of track with the above named rise and fall.

Item No.2 (Ballast) 10% allowed, due to shortened life of ballast on grades, caused by fine coal from tenders and cinders from locomotives dirtying up the ballast. Also on account of rail running on down hill track.

Item No.3 (Ties) 10% for practically the same reason given in the cost of ballast.

Item No.4 (Rails) 10% on account of action of brakes and running of rails. This item would probably be somewhat larger but it has been partially covered under consideration of Curvature.

Item No.5 (Other Track Materials) 10% on account of rail running making it necessary to use anti creepers or block the ties.

Item No.34 (Repairs to Locomotives) Allowed 3% on the basis that repairs to pumps, tires and machinery would be about 50% of all locomotive repairs, and that these would be increased about 10% when running over grades steep enough to require the use of brakes, and about 60% of all engines are in road service.

All other items No.35 - 47 covering repairs and shop machinery and tools, is put in at the same figure. It is quite probable that this is somewhat low for freight cars.

Item No.80 (Fuel for Road Locomotives) This is placed at 50%. There is considerable loss due to engine working at lower effeciency when pulling a heavy load at 10 miles per hour. Also a loss due to poor combustion at low speeds. Again, more or less energy is wasted in braking the train down, and steam pumps consume considerable steam. Tests have been made where a 20% increase in tonnage showed

50% more coal consumed.

In the first part of Column No.8, Table No.5, under the sub-heading Class-B, is given the percent of items effected by the elimination of rise and fall where grades are such as to require shutting off steam in descending but not such as to require application of the brakes.

SUMMARY OF SAVINGS TO BE EXPECTED,- Tables Nos.7,8,9, and 10, show the present number of slow and fast trains both east and westbound over the present line, and also the estimated number of trains over the four proposed lines. These tables also show present and estimated number of pusher engine miles, light engine miles, and light engine pusher miles. In estimating the number of trains for the proposed lines, the present Buffalo Division rating was used. This is shown on the bottom of the tables. It will be seen that the proposed number of trains is the same in all cases, except the Nichols Line, and only the number of pusher and light engine mileage vary. The fact that all of the proposed schemes for grade reduction are the greatest help to traffic in the direction in which the traffic is the lightest, thus tending to largely unbalance the traffic, is a point that must be taken into consideration in figuring proposed train movements.

It very often happens that the actual tonnage handled over a given division for a long period is very much less than the engine rating would indicate. Over the territory in question, however, the tonnage actually handled has usually been close to 100% of the engine rating. There is no reason why the proposed tonnage cannot be handled at all times, as the engine rating of engines in use will be considerably in excess of the given tonnage.

The distance between Clarks Summit and Hallstead, or the line over which the slow freights will be affected by the change in grade, is practically forty-one miles. All of the fast freights will be affected from Clarks Summit to Binghamton, sixty-one miles, and a part will be affected from Binghamton to Elmira, a distance of fifty-seven miles. Therefore, the train miles saved on slow trains on account of reduction in grade is determined by multiplying the number of trains saved per annum by the distance in miles. The result multiplied by the cost per train mile for the addition or elimination of one train as shown on Table No.4, gives the saving to be expected in cost of operation on account of reduction in grade.

The total number of train miles saved on account of reduction in distance is found by taking the sum of all classes of estimated trains in both directions and multiplying this by the number of miles the distance is reduced. The result in train miles multiplied by the cost per train mile for the elimination of distance, or $.9155, as shown on Table No.4, gives the total saving to be expected on account of eliminating distance.

In figuring the total amount saved on account of eliminating curvature the total curvature is reduced to a five degree curve, the result in miles is multiplied by the total number of trains per annum, and thence by the decimal .29112 shown in Table No.4.

In a similar manner we arrive at the saving due to helper engines, and rise and fall. The calculations for the total savings on all lines figured on 1908 business and on the estimated business five and ten years hence is given on Tables Nos.13,14,15,

and 16, the totals only being shown on Tables Nos. 5, and 12.

In all these tables the saving due to elimination of Hallstead Yard is shown. This amount is only one-half the estimated saving due to constructing a hump yard near Scranton to do the switching now being done at Hallstead. The revision of the present line will make it possible to handle trains through, saving the necessity of a yard at Hallstead. The switching, however, which is done at Hallstead must be done at some point, and since a modern yard constructed at Hallstead would greatly reduce the present yard expenses at that point, it is reasonable to credit but one-half the saving due to eliminating Hallstead Yard to the proposed new line.

In Tables Nos.5, and 12, the allowable credit shown consists of the expense of constructing third track (which will otherwise have to be built), the elimination of grade crossings on the present line, the reconstruction of Nicholson bridge, the relaying and the scrap rail which would be relieved, etc.

COST OF CONSTRUCTION COMPARED WITH NET ESTIMATED SAVING PER ANNUM CAPITALIZED AT FOUR .....PERCENT.....

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From Table No.5, it will be noted that the total cost of constructing the Short Line is $7,614,691, or about $650,000 more than the net savings capitalized at four percent. After making due allowance for credits, however, it will be seen that there is a net saving of $840,082.95 based on 1908 business.

Likewise the Tunkhannock Line shows a net loss of $22,173.33, while the Nichols Line and Martins Creek Line show a net loss of $13,687,881.21 and $139,818.60 respectively.

By reference to Table No.3, we see that the average yearly increase of freight and coal traffic was 4.4% between the years 1899 and 1908. It will also be seen that 1908 was an exceptionally low year and as our figures are based on the 1908 business we are justified in assuming that the business will have increased at least 22% over 1908 in the year 1913, and likewise 44% in 1918.

Table No.11, shows the percentage of increase and decrease in cost per train mile for the years 1899 to 1908 inclusive. This table shows an average yearly increase in cost of operation of 5.4%. Therefore, in estimating on the cost of operating in 1913 and 1918 I have assumed that this average yearly increase in the cost of operating per train mile will continue.

Table No.12, represents the same items as Table No.5, assuming that the increase in cost of operation and the increase of business will continue as it has in the past ten years as explained above. From this table we find that in 1913 the Short Line would show a net saving equal to the interest on $3,544,711.95. In 1918 the net saving would be equal to the interest on $7,797,823.20. The Tunkhannock and Martins Creek Lines show even larger savings, while the Nichols Line shows a net loss in 1918 equal to the interest on $3,765,000.

C O N C L U S I O N S

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In comparing the various lines under consideration, we find that the Short Line makes the best showing based on 1908 business. Considering the assumed business of 1913 and 1918 the Tunkhannock Line makes the best showing, with the Martins Creek

Line better than the Short Line in both cases.

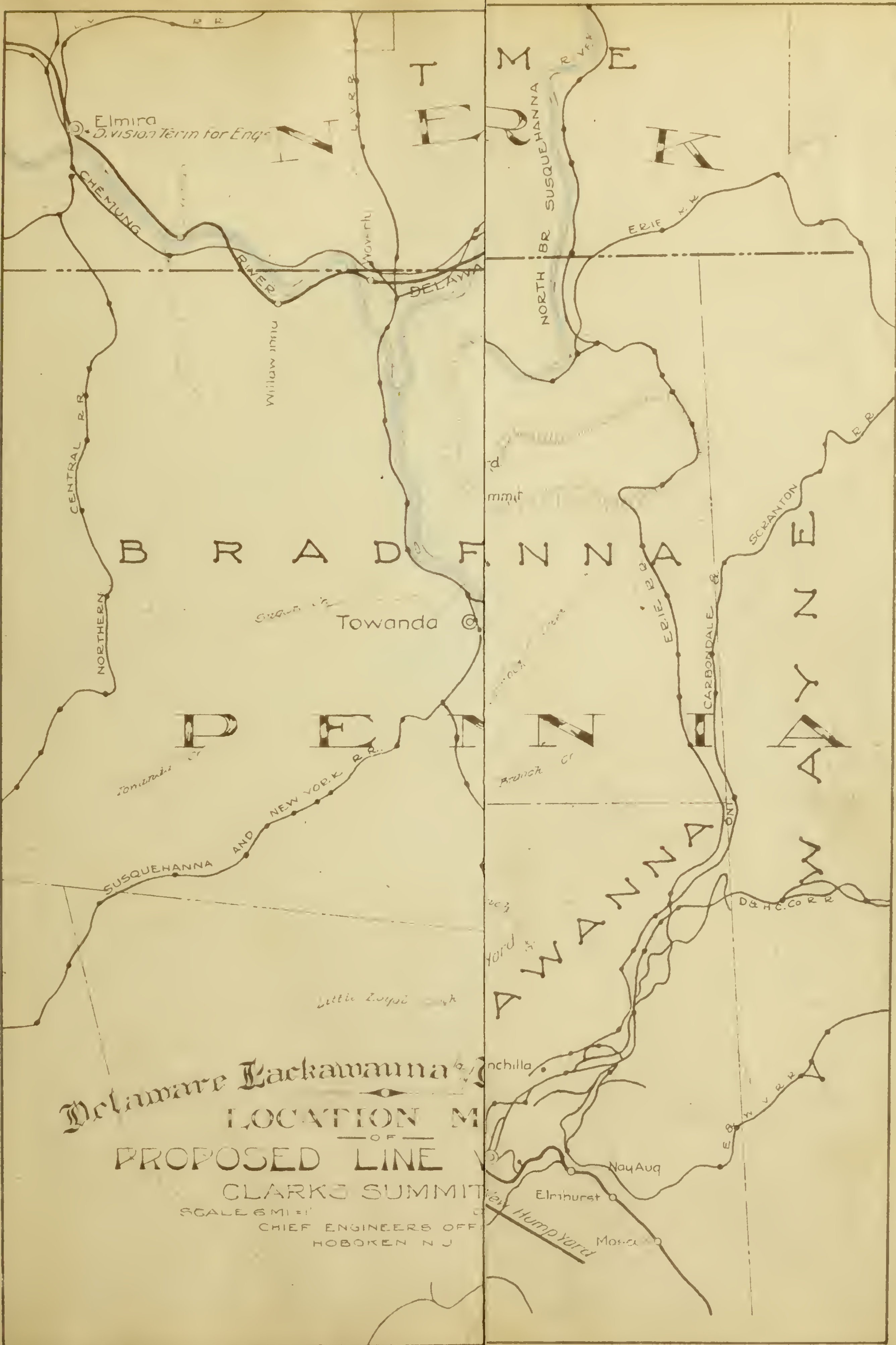
The extensive cost of the Nichols Line, the fact that the old line would have to be maintained between Factoryville and Binghamton, and the same showing a net loss in 1918, eliminates it from further consideration.

The Tunkhannock Line passes through a new country so far from the present line that in all probability a part of the present line would have to be maintained for the local business. The viaduct construction on this line would be very expensive and while this expensive work has been taken into consideration in the estimates the class of construction necessary makes the chance of failure or accident much greater than would be the case with the Short Line or Martins Creek Line. Furthermore, as explained under the comparison of these lines in the forepart of this discussion, the long tunnel at New Milford Summit would be very objectionable. All materials for construction would have to be handled by teams and temporary lines, and the length of time necessary to complete the work would be much longer than would be required for the Short Line or the Martins Creek Line.

After carefully considering all of the advantages and disadvantages of the various lines, I think that the Martins Creek Line is the best. With this line all of the sharp curves are eliminated between Hallstead and Clarks Summit. There is but one comparatively short tunnel and also only one viaduct, making it the easiest line upon which to make later additions, should such additions become necessary with increasing business. This line would also eliminate all westbound pusher service, and it would not be necessary to maintain any part of the present alignment between

Hallstead and Clarks Summit. Its capacity would be greater than any of the other proposed lines.

That it would pay to construct the Martins Creek Line there could be no doubt. In addition to the saving shown by the preceding figures, many advantages are to be gained on which a monetary value cannot well be placed. The saving in time on freight trains would make it easier to keep within the sixteen hour law. Trains would be moved over this congested territory in less time. Passenger trains could make considerably better time, and should the passenger business increase it would be possible to add one or two coaches to most all of the passenger trains without requiring helper engines. The danger of operating on sharp curves would be practically eliminated, with added comfort to the traveling public.


Elmira
Division Term for Engs
NEW YORK
CHEMUNG RIVER
NORTH BR SUSQUEHANNA RIVER
ERIE R.R.
DELAWA
Towanda
BRADFORD
PENNA
SUSQUEHANNA AND NEW YORK R.R.
NORTHERN CENTRAL R.R.
ERIE R.R.
CARBONDALE & SCRANTON R.R.
WAYNE
D.&H.C.Co R.R.
E. & W.V.R.R.
Nay Aug
Elmhurst
Hump Yard
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LOCATION M
OF
PROPOSED LINE
CLARKS SUMMIT
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CHIEF ENGINEERS OFF
HOBOKEN N J

Delaware Lackawanna & Western R.R.
LOCATION MAP
OF
PROPOSED LINE WEST OF
CLARKS SUMMIT, PA.
CHIEF ENGINEERS OFFICE
HOBOKEN N J
NEW YORK
TIOGA
BROOME
Owego
Binghamton
Apalachin
Nichols
Conklin Centre
Lestershire
STATE LINE
Hallstead
Present Yard
New Milford
New Milford Summit
Montrose
BRADFORD
SUSQUEHANNA
PENNSYLVANIA
Towanda
Alford
Kingsley
Martins Creek Line
Tunkhannock Line
Short Line
Nicholson
Tunnel
Factoryville
Plume
Dalton
Glenburn
Clarks Summit
Tunkhannock
WYOMING
LACKAWANNA
WAYNE
Chinchilla
Scranton
Nay Aug
Elmhurst
LUZERNE
SUSQUEHANNA AND NEW YORK R.R.
SUSQUEHANNA RIVER
NORTH BRANCH CANAL
SCRANTON DIVISION
ERIE R.R.
WATER DIVIDE
Kingston District

PROFILES OF PRESENT AND PROPOSED LINES

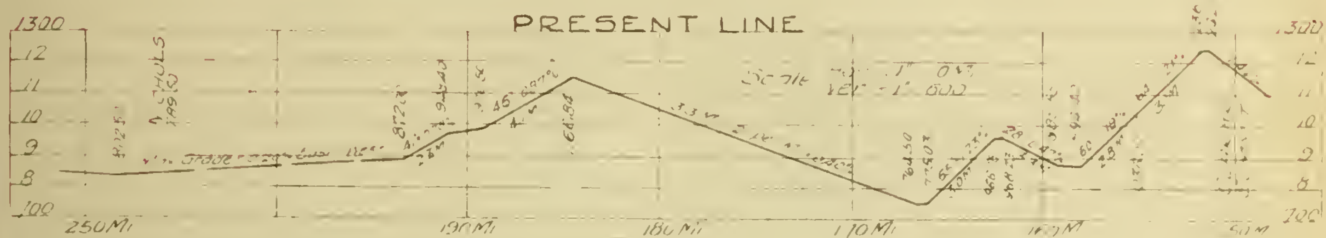

Fig 1

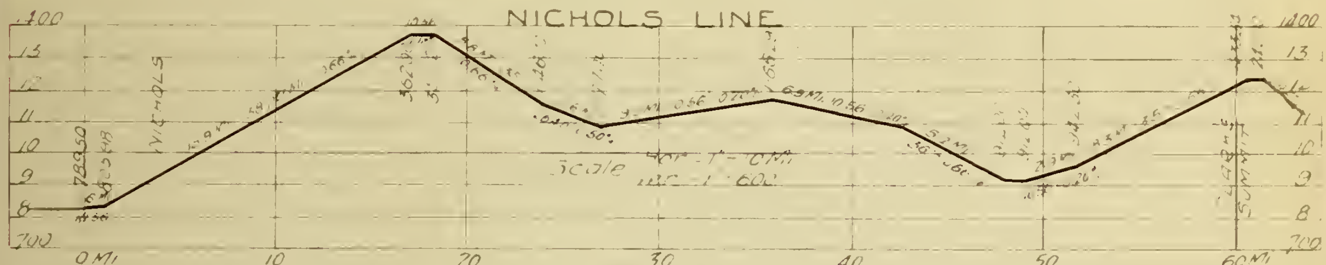

Fig 2

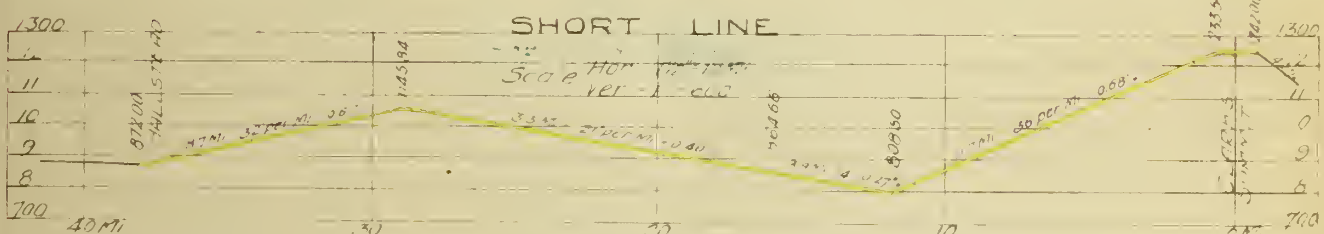

Fig 3

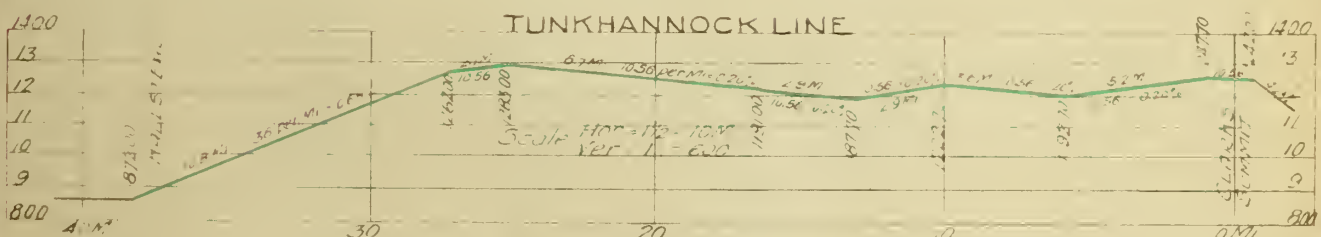

Fig 4

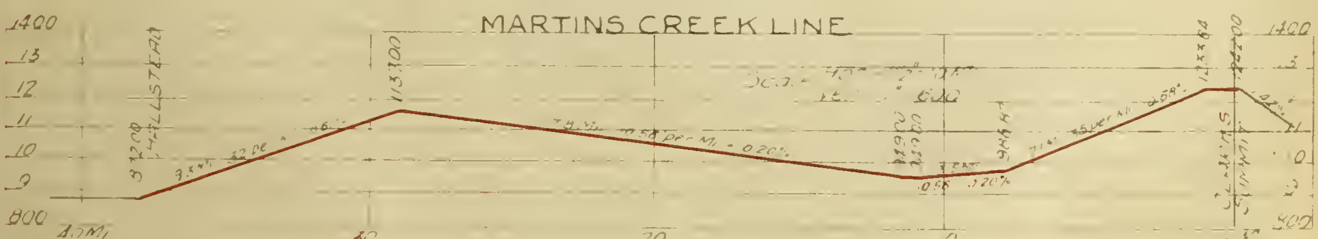

Fig 5

TABLE NO. 1

RATING OF LOCOMOTIVES IN Ms

RATING Nº	ENGINE NAME	TOTAL WGT OF ENGINE	TOTAL WGT ON DRIVERS	SCRANTON TO CLK SUMT	CLK SUM'T TO HALLSTEAD	HALLSTEAD TO BINGHAM (Same as Buffalo Div Rating)	BINGHAM TO HALLSTEAD (Same as Buffalo Div Rating)	HALLSTEAD TO NICHOLSON		NICHOLSON TO CLARKS SUMMIT		BINGHAM TO SCRANTON (Same as Buff Div Rating Fast Freight Rating)	SCRANTON TO BINGHAM (Same as Buff Div Rating Fast Freight Rating)
								Loads	Empties	Loads	Empties		
1	Consolidation	200,000	177,000	1250	3200	5395	5395	2025	1820	1470	1320		
2	12 Wheeler	200,000	158,000	1100	2850	4900	4900	1770	1590	1320	1190		
3	Consolidation	186,000	166,000	1050	2800	4560	4560	1660	1490	1250	1130	2200	1900
3A	10 Wheeler 1000 Class	171,500 / 206,000 / 214,000	150,500 / 156,000 / 168,000	865	2485	4200	4200	1590	1430	1190	970	1950	1750
4	Mogul	179,000	137,000	830	2300	3940	3940	1400	1260	1055	950	1800	1560
5	Consolidation	126,500	109,100	780	2130	3520	3520	1300	1170	1000	900	1700	1255
6	Mogul 600 Class	115,000	100,000	650	1800	2970	2970	1100	990	840	760	1500	1110

TABLE NO. 2.
ENGINE RATING CURVES

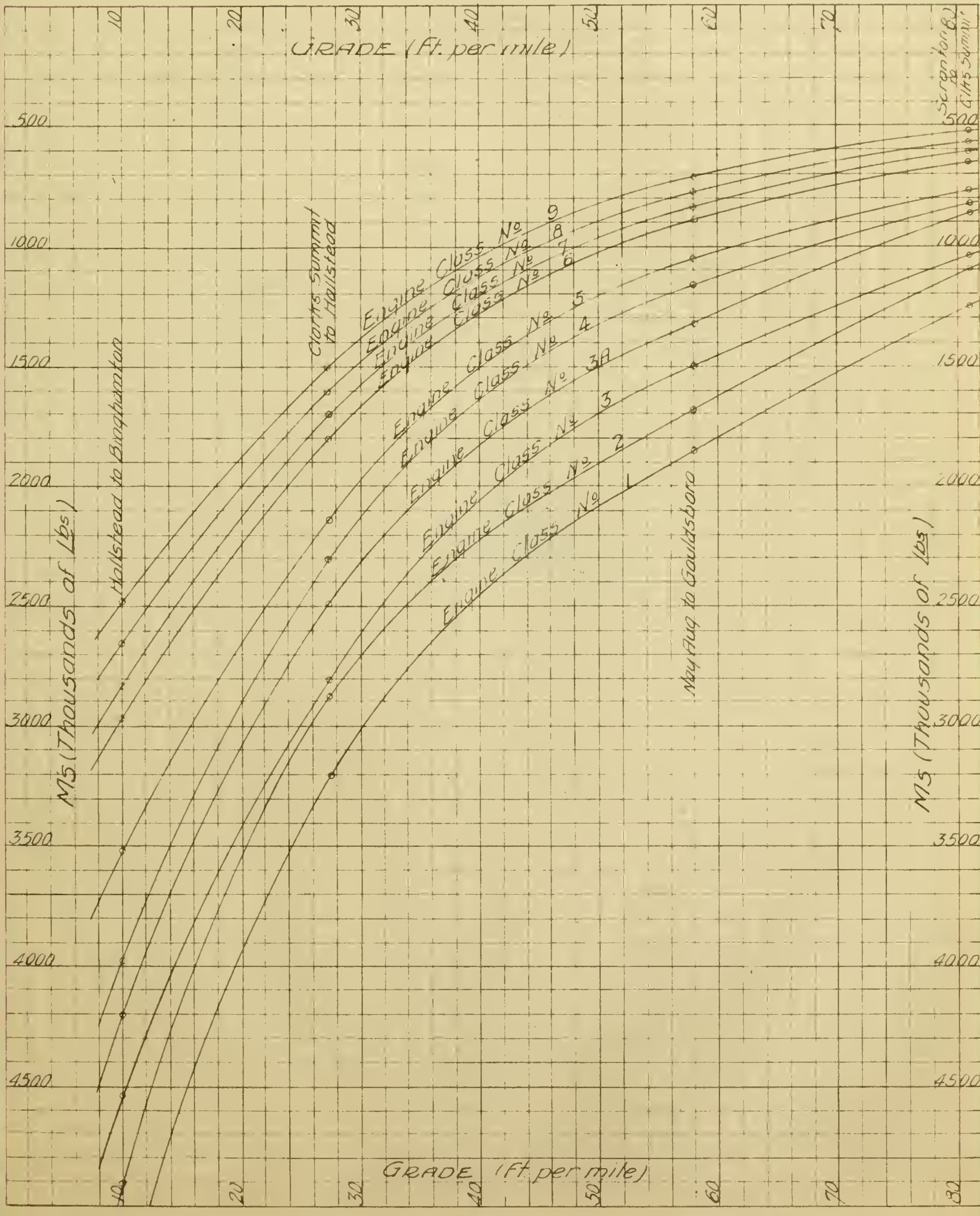

TABLE NO. 3.

TABLE SHOWING PERCENT OF INCREASE & DECREASE OF FREIGHT & PASSENGER TRAFFIC.

1899 - 1908

FREIGHT & COAL						PASSENGER					
YEAR	FREIGHT AND COAL Net Tons	INCREASE	DECREASE	PER CENT OF INCREASE	PER CENT OF DECREASE	YEAR	PASSENGERS NUMBER	INCREASE	DECREASE	PER CENT OF INCREASE	PER CENT OF DECREASE
1899	12,608,501	432,669	00	3.5		1899	12,969,893				
1900	12,481,875	00	640,220		5.8	1900	14,428,880	1,458,987	00	10.0	
1901	13,958,710	1,476,835	00	11.8		1901	15,025,996	597,116	00	3.9	
1902	11,214,559	00	2,827,567		20.2	1902	16,228,335	1,202,339	00	7.4	
1903	16,685,846	5,471,287	00	48.0		1903	17,604,035	1,375,700	00	7.8	
1904	15,912,477	00	773,369		4.6	1904	17,946,686	342,651	00	1.9	
1905	17,335,739	1,423,262	00	8.9		1905	19,378,522	1,431,836	00	7.3	
1906	18,095,267	759,528	00	4.3		1906	21,532,943	2,154,421	00	10.0	
1907	21,082,119	2,986,852	00	16.5		1907	23,223,663	1,690,720	00	7.2	
1908	18,199,155	00	2,882,964		13.6	1908	23,666,228	442,565	00	1.9	

Average Yearly Increase of Freight and Coal = 4.4%
Increase of 1908 over 1893 = 44.3%
Increase " " " 1903 = 9.0%

Average Yearly Increase of Passenger Traffic = 6.4%
Increase of 1908 over 1899 = 82.4%
Increase " " " 1903 = 34.4%

TABLE NO. 4.

TABLE SHOWING EFFECT ON MAINTENANCE & OPERATING EXPENSE OF CHANGES IN GRADE, CURVATURE, DISTANCE & RISE & FALL

SEE NOTE BELOW FOR BASIS OF FIGURE

1 ITEM	2 1908 Maintenance and Operating Expenses — Amount	3 Per cent of Total	4 Grade — Per cent Affected	4 Grade — [illegible]	5 Distance — Per cent Affected	5 Distance — [illegible]	6 Helper — Per cent Affected	6 Helper — [illegible]	7 Curvature — Per cent Affected	7 Curvature — [illegible]	8 Rise & Fall Class B — [illegible]	8 Rise & Fall Class B — [illegible]	8 Rise & Fall Class C — [illegible]	8 Rise & Fall Class C — [illegible]
[illegible] & STRUCTURES														
1 Superintendence	34,858.27	19												
2 Ballast	2[illegible],821.96	1.12	20	.22	100	.12	15	.16	50	.56			[illegible]	.12
3 Ties	460,839.58	2.56	20	.51	100	2.56	15	.38	50	1.28			10	.26
4 Rails	23[illegible],385.32	1.28	50	.64	100	1.28	37	.47	100	5.12	5	.06	10	.13
5 Other Track Material	149,225.86	.83	20	.17	100	.83	15	.12	300	2.49	5	.04	10	.08
ROADWAY & TRACKS														
6 [illegible] and Watching	65,171.44	.36			100	.36								
7 Bank Protection	10,468.69	.06			100	.06								
8 [illegible]	135.38													
9 [illegible]	40,021.77	.22	37	.08	100	.22	28	.06	10	.02				
10 Other Expenses	829,346.18	4.62			100	4.62								
11 Removal of Snow and Ice	40,374.73	.22			100	.22								
12 Tunnels	26,878.03	.14			100	.14								
13 Bridges and Culverts	247,913.68	1.38			100	1.38								
14 Over and Under Crossings	31,035.90	.16			100	.16								
15 Crossing Fences and Signs	67,040.22	.37			100	.37								
16 Snow Fences and Sheds	1,374.72	.01			100	.01								
SIGNALS & INTERLOCKING														
17 Interlocking Plants	84,251.89	.46	37	.16	100	.43	28	.12						
18 Signals	62,571.63	.34	60	.20	100	.34	45	.15						
19 Other Expenses	169.20													
20 Teleg. and Teleph. Lines	35,141.19	.19	10	.02	75	.14	6	.01						
BUILDINGS, FIXTURES & GROUND														
21 Buildings	289,355.51	1.60												
22 Fixtures	8,296.15	.04												
23 Machinery	25,772.83	.14												
24 Grounds	33,333.09	.18												
25 Other Expenses	86,023.21	.47												
26 Docks and Wharves	35,934.85	.19												
27 Roadway Tools and Supplies	28,005.14	.15	37	.06	100	.15	28	.04	100	.15				
28 Injury to Persons	16,686.04	.09	100	.09	100	.09	75	.07						
29 Stationery and Printing	9,708.66	.05												
30 Insurance	37.50													
31 Other Expenses	9,7[illegible]9.87													
32 Joint Tracks and Yards	115,210.14	.63												
MAINTENANCE OF EQUIP														
33 Superintendence	85,259.42	.50												
34 Steam Locomotive Repairs	1,239,090.21	6.88	62	4.27	80	5.50	46	3.16	30	2.06	1	.07	3	.21
35 Renewals	11,087.44	.06	62	.04	80	.05	46	.03	30	.02		.02	3	.00
36 Depreciation	306,075.40	1.70	62	1.05	80	1.36	46	.78	30	.51		.02	3	.05
37 Passenger Cars Repairs	524,628.05	2.91			85	2.47			30	.87		.03	3	.09
38 Renewals	9,767.93	.05			85	.04			30	.02	1	.00	3	.00
39 Depreciation	93,614.24	.52			75	.39			30	.16	1	.01	3	.02
40 Freight Cars Repairs	1,509,336.44	8.40			75	6.30			30	2.52	1	.08	3	.25
41 Renewals	36,[illegible]19.31	.20			75	.15			30	.06	1	.00	3	.06
42 Depreciation	769,695.[illegible]0	4.28			75	3.21			30	1.28	1	.04	3	.13
43 Work Equipment Repairs	25,269.51	.14	25	.03	75	[illegible]	9	.01	30	.04	1	.00	3	.00
44 Renewals	1,853.80	.01	25	.03	75	[illegible]	19	.00	30	.00	1	.00	3	.00
45 Depreciation	20,820.20	.10	25	.03	75	.08	9	.02	30	.03	1	.00	3	.00
SHOP MACHINERY & TOOLS														
46 Repairs	86,401.20	.48	30	.14	75	.36	22	.11	30	.14	1	.00	3	.02
47 Renewals	37,036.24	.20	30	.06	75	.15	22	.04	30	.06	1	.00	3	.01
48 Injury to Persons	5,945.17	.03	30	.01			22	.01						
49 Stationery and Printing	10,920.63	.06												
50 Other Expenses	5.55													
51 Equipment Borrow	24,823.14	67												
TRAFFIC EXPENSES														
52 Superintendence	52,07[illegible]	[illegible]												
53 Outside Agencies	100,9[illegible]1.55	.56												
54 Advertising	[illegible],282.67	.56												
55 Traffic Associations	21,504.84	.12												
56 [illegible]	[illegible]	[illegible]												
57 Industrial and Immigration Bureaus	6,6[illegible]	.03												
58 Stationery and Printing	48,704.85	.25												
59 Other Expenses	825.84	.00												
TRANSPORTATION EXPENSES														
60 Superintendence	165,5[illegible]6.13	.90												
61 Dispatching Trains	59,675.31	.30	5	.08			10	.03						
STATION EMPLOYEES														
62 Agents, Clerks & Attendants	907,615.40	5.04												
63 Labor at Stations	513,142.40	2.84												
64 Car Service Associations	9,208.40	.05												
65 Stock Yards and Grain Elevators	1,793.16	.01												
66 Station Supplies and Expenses	121,724.79	.67												
67 Yardmasters and Clerks	233,834.34	1.28												
68 Yard Conductors & Brakemen	609,391.47	3.38												
69 Yard Switch and Signal Tenders	40,617.15	.22												
70 Yard Supplies and Expenses	8,780.38	.04												
71 Yard Enginemen	362,758.77	2.01												
72 Engine House Expenses (Yard)	99,382.33	.55												
73 Fuel for Yard Locomotives	226,2[illegible]3.12	[illegible]												
74 Water	33,262.71	[illegible]												
75 Lubricants	8,787.37	.04												
76 Other Supplies Yard Locomotives	9,862.26	.06												
77 Operating Joint Yards	9,390.40	.05												
78 Road Enginemen	1,087,742.94	6.04	100	6.04	100	6.04	100	6.04						
79 Engine House Expenses (Road)	309,201.20	1.70	100	1.70	100	1.70	100	1.70						
80 Fuel for Road Locomotives	1,751,523.75	9.74	100	9.74	100	9.74	100	9.74	25	2.43	15	1.46	50	4.[illegible]
81 Water	113,470.13	.63	60	.38	100	.63	60	.38			15	.09	50	[illegible]
82 Lubricants	42,362.70	.23	100	.23	100	.23	100	.23	25	.06	15	.03	50	.13
83 Other Supplies Road Locomotives	42,839.42	.23	100	.23	100	.23	100	.23						
84 Road Trainmen	1,181,366.49	6.57	100	6.57	100	6.57	33	.6						
TRAIN SUPPLIES & EXPENSES														
85 Cleaning Cars	92,627.68	.50												
86 Heating Cars	12,064.92	.06			30	.02								
87 Lighting Cars	36,687.45	.20			30	.06								
88 Lubricating Cars	54,646.64	.30			80	.24								
89 [illegible] Cars	26,652.50	.14												
90 [illegible] Trains	720.35													
91 [illegible]	13,252.59	.07												
92 Other Expenses	124,761.50	.68	75	.51			75	.51						
93 [illegible], Block etc. Signals	174,586.73	.96			100	.96			25	.24				
94 Crossing Flagmen and Gatemen	170,426.21	.94			100	.94								
95 Drawbridge Operation	17,846.44	.09												
96 Clearing [illegible] Tracks	21,377.06	[illegible]			50	.06								
97 Teleg. and Teleph. Operation	56,768.05	.31			[illegible]	.26								
98 Stationery and Printing	91,691.67	.59												
99 Insurance	1,423.74	.00												
100 Other Expenses	8,989.99	.04												
101 Loss and Damage Freight	284,801.22	1.57	15	.24	75	1.18			10	.16				
102 Loss and Damage Baggage	1,985.07	.01			50	.01								
103 Damage to Property	25,513.52	.14			50	.07								
104 Damage to Stock on Right of Way	2,412.75	.01												
105 Injury to Persons	92,034.58	.51			50	.26	10	.05						
106 Operating Joint Tracks & Facilities	78,802.75	.42												
TOTAL	17,973,138.82	100.0		33.61		62.66		26.83		20.28		1.95		.659

	Grade	Distance	Helper	Curvature	Class B	Class C
	33.61	62.66	26.83	20.28	1.95	.59
Cost per Train Mile	1.436	1.436	1.436	1.436	1.436	1.436
Total	47.29	89.98	38.53	29.12¢	2.800¢	.9403¢
Interest Charge	1.22	1.57	1.40			
Saving in Cents Grand Total	48.51¢	91.55	39.93¢			

Total Passenger Train Mileage 5,732,804.00
Total Freight Train Mileage 6,784,035.00
Total 12,516,839.00

Cost per Train Mi = $\frac{17,973,138.82}{12,516,839.00}$ = 1.436¢

NOTE —
Figures for Grade are based on the addition or elimination of one train [illegible]
Figures for Distance are based on the elimination of one mile
Figures for Helper Engines are based on the elimination of one helper mile
Figures for Curvature are based on one mile of 5° curve compared with the average curvature [illegible]
Figures for Rise and Fall are based on the comparison between two miles of level tangent track and 2 miles of tangent track with a hump of 26.4 feet in the middle

TABLE NO. 5.

TABLE SHOWING SAVING OF PROPOSED LINES OVER PRESENT LINE

BASED ON 1908 BUSINESS

CLASS	SHORT LINE	TUNKHANCK LINE	NICHOLS LINE	BING-CLARK SUMMIT LINE	MARTINS CR. LINE
LENGTH	23.8 Mi.	37.7 Mi.	60.00 Mi.	x	35.8 Mi.
REDUCTION OF GRADES	145,090.99	145,090.99	75,578.58	29,827.63	145,090.99
ELIMINATION OF DISTANCE MILES	3.4 Mi.	4.7 Mi.	27.0 Mi.	2.0 Mi.	3.8 Mi.
AMOUNT SAVED	57,092.81	79,155.23	257,986.98	18,355.77	59,955.88
CURVATURE	2459°	2442°	2933°	003°	21,9°
AMOUNT SAVED	49,819.31	49,283.62 ○	32,671.98	11,095.26	43,391.01
RISE & FALL "B" *	653	3	921	274	26
" " " "C"	951	951	951	364	351
AMOUNT SAVED	24,960.91	31,350.72	10,497.59	5,083.38	30,072.76
PUSHER MILES	▫ 36,892.93	44,715.61	▫ 14,189.93	—	46,983.63
BINGHANTON to ELMIRA Fast Freight	9,041.78	9,041.78	00	00	9,041.78
HALLSTEAD YARD	29,499.30	29,499.30	00	20,694.51	29,499.30
NET TOTAL SAVINGS	278,612.17	388,137.25	553,005.96		364,035.35
CAPITALIZED AT 4%	6,965,304.25	9,703,431.25	3,825,149.00		9,100,883.75
ESTIMATED COST OF CONST.	7,614,691.00	10,506,073.58	28,092,602.21		11,146,602.75
ALLOWABLE CREDIT	1,489,469.70	780,469.00	579,572.00		1,905,900.40
NET COST	6,125,221.30	9,725,604.58	27,513,030.21		9,240,702.35
NET SAVINGS Capitalized	840,082.95	22,173.33	13,687,881.21		139,818.60

* Increase ○ Decrease ▫ Loss x = Savings due to Reduction between Clarks Summit & Present tunnel … trains running via … [illegible]

ESTIMATE COST OF CONSTRUCTION

SHORT LINE
FIGURED FOR

3 Tracks Clarks Summit to Nicholson
(Four) 2 Track Improvements Foster to New Milford Summit
3 Tracks New Milford Summit to New Milford Station
4 Tracks New Milford Station to Hallstead
Total Estimate Cost of Construction = $7,614,691.00
Total Credit for relieved rail, scrap
Grade Crossings which will otherwise
have to be eliminated. Construction of
3rd Track Clark Summit to Nicholson and
Hallstead to New Milford $1,489,469.70
Net Cost $6,175,221.30

TUNKHANNOCK LINE
FIGURED FOR

2 Tracks with Passing sidings Hallstead to Clarks Summit
Total Estimated Cost $10,506,073.58
Total Credits = 780,469.00
Net Cost $9,725,604.58
If 3 Tracks are constructed from Hallstead
to New Milford Summit the Net cost becomes $9,818,729.52

MARTINS CREEK LINE
FIGURED FOR

3 Tracks Clarks Summit to New Milford Summit
and 4 Tracks from New Milford Summit to Hallstead
Total Estimated Cost of Construction = $11,146,602.75
Total Credits 1,905,900.40
Net Cost $9,240,702.35

NICHOLS LINE
FIGURED FOR

2 Tracks Nichols to Factoryville and 3 Tracks from
Factoryville to Clarks Summit
Total Estimated Cost of Construction $28,092,602.21
Total Credits 579,572.00
Net Cost $27,513,030.21

TABLE NO. 6.

TABLE OF CHARACTERISTICS & COST PROPOSED LINES WEST OF CLARKS SUMMIT.

CLASS		SHORT LINE	TUNKHANNOCK LINE	NICHOLS LINE	MARTINS CR. LINE
FILL (EMBANKMENT)		7,739,999 Cu.Yds	7,540,326 Cu.Yds	20,329,596 Cu.Yds	11,421,340 Cu.Yds
EXCAVATION	ROCK	3,849,182 " "	4,471,806 " "	14,647,025 " "	7,780,382 " "
	EARTH	1,635,660 " "	927,990 " "	333,020 " "	550,440 " "
TUNNELS	NUMBER	2	3	5	1
	LENGHT	6000-1600 Feet	1200-2780-7800	1400-1800-1030-4075-4750 Feet	2,955 Feet
	EXCAVATION	202,667 Cu.Yds	311,733 Cu.Yds	348,794 Cu.Yds	78,600 Cu.Yds
	SHAFT	197,000 " "	216,710 " "	532,735 "	00 " "
BORROW		20,760 " "	00 " "	278,477 "	00 "
WASTE		273,323 " "	60,016 " "	229,224 " "	00 "
CONCRETE	BRIDGE & CULV.	88,244 " "	81,445 " "	155,034 " "	96,490 "
	VIADUCT	53,385 " "	64,103 " "	754,676 " "	159,850 " "
STEEL	REINFORCING	580 Tons	656 Tons	8,557 Tons	1,940 Tons
	BRIDGE	14,300 lbs	22,000,000 lbs	318,940 lbs	87,800 lbs
LENGHT OF TRACK		125,665 Feet	199,056 Feet	357,456 Feet	188,885 Feet
COST OF CONSTRUCTION		⊠$ 7,614,691.00	*$ 10,506,073.58	*$ 28,092,602.21	⊙$ 11,056,549.75

NOTE:-
* Tunkhannock Line & Nichols Line = 2 Tracks
⊙ Martins Creek Line = 3 Tracks
⊠ Short Line = 2 and 3 Tracks

TABLE-NO. 7.
SHORT LINE
TABLE SHOWING PRESENT & PROPOSED TRAIN MOVEMENT

EASTBOUND

KIND	TRAINS PER YEAR			PRESENT			PROPOSED			LIGHT ENG Elmira to Bing Miles
	PRESENT	PROPOSED	DIFF.	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI	
Slow Freights	5733	2303	3430	121,220	00	00	92,120	41,692	48,480	
Fast Freights	2110	1798	312	75,152	20,387	23,606	71,920	13,450	15,640	* 18,639
Pass. Milk & Exp.	4276	4276	00	32,120	00	00	00	00	00	00
Total	12,119	8,377	3,742	228,492	20,387	23,606	164,040	55,140	64,120	18,639

WESTBOUND

KIND	TRAINS PER YEAR			PRESENT			PROPOSED			FAST FRT Binghamton to Elmira
	PRESENT	PROPOSED	DIFF	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI	
Slow Freights	7433	4727	2706	7360	00	00	160,718	00	00	
Fast Freights	1483	1016	467	6,656	00	00	34,544	00	00	° 327
Pass. Milk & Exp	4,276	4276	00	00	00	00	00	00	00	
Total	12,192	10,019	3,173	14,016	00	00	195,262	00	00	327

EASTBOUND

TONNAGE RATING CLASS 3 ENGINE	M'S PER TRAIN		
	PRESENT	PROPOSED	DIFF.
Slow Freights	1832	4560	2728
Fast "	2301	2700	399

WESTBOUND

TONNAGE RATING CLASS 3 ENGINE	M'S PER TRAIN		
	PRESENT	PROPOSED	DIFF.
Slow Freights	2900	4560	1660
Fast "	1849	2700	851

NOTE:-

* Number of Light Engine Miles Saved.

° Number of Trains Saved

Proposed Trains Based on 1908 Tonnage.

TABLE-NO. 8
TUNKHANNOCK LINE
TABLE SHOWING PRESENT & PROPOSED TRAIN MOVEMENT

EASTBOUND

KIND	TRAINS PER YEAR			PRESENT			PROPOSED			LIGHT ENG
	PRESENT	PROPOSED	DIFF	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER M.	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER M.	Elimi to Bing MILES
Slow Freights	5733	2303	3430	121,220	00	00	50,606	42,692	18,062	
Fast Freights	2110	1798	312	75,152	20,387	23,606	39,556	21,114	8,602	* 18,639
Pass. Milk & Exp.	4276	4276	00	32,120	00	00	00	00	00	00
Total	12,119	8377	3,742	228,492	20,387	23,606	90,162	63,806	26,664	* 18,639

WESTBOUND

KIND	TRAINS PER YEAR			PRESENT			PROPOSED			[illegible]
	PRESENT	PROPOSED	DIFF	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER M.	[illegible]
Slow Freights	7,433	4,727	2,706	7,360	00	00	00	[illegible]	[illegible]	
Fast Freights	[illegible]483	1,016	[illegible]	[illegible]	00	00	00	[illegible]	00	° 327
Pass. Milk & Exp.	4,276	4,276	[illegible]	[illegible]	00	00	00	[illegible]	[illegible]	
Total	12,192	10,019	3,173	14,016	00	00	00	00	00	° 327

EASTBOUND

TONNAGE RATING CLASS 3 ENGINE	M'S PER TRAIN		
	PRESENT	PROPOSED	DIFF
Slow Freights	1832	4560	2728
Fast "	2301	2700	399

WESTBOUND

TONNAGE RATING CLASS 3 ENGINE	M'S PER TRAIN		
	PRESENT	PROPOSED	DIFF
Slow Freights	2900	1560	1660
Fast "	1849	2700	851

NOTE:-
* Number of Light Engine Miles Saved
° Number of Trains Saved
Proposed Trains Based on 1908 Tonnage

TABLE-NO.9
NICHOLS LINE
TABLE SHOWING PRESENT & PROPOSED TRAIN MOVEMENT

EAST BOUND

PRESENT

LOCATION	TRAINS PER YEAR Number	Dist.	LIGHT ENG MILES	LIGHT ENG. PUSHER MI	PUSHER MILES
SLOW FREIGHT					
Elmira to Binghamton	2455	57	23,878	00	424
Binghamton to Hallstead	2747	14	29,554	00	00
Hallstead to Clarks Summit	5733	40	22,533	00	121,220
FAST FREIGHT					
Elmira to Binghamton	2,110	57	00	00	3,688
Binghamton to Scranton	2,110	61	00	23,606	75,152
PASSENGER MILK & EXPRESS					
Elmira to Clarks Summit	4,276	111	00	00	32,120

PROPOSED

LOCATION	TRAINS PER YEAR Number	Dist.	LIGHT ENG MILES	LIGHT ENG PUSHER MI	PUSHER MILES
SLOW FREIGHT					
Elmira to Binghamton	736	57	00	00	00
Binghamton to Hallstead	1,350	14	10,360	00	00
Hallstead to Clarks Summit	2,336	38	6,403	6,403	26,906
Elmira to Clarks Summit	1,382	84	78,290	28,362	10,164
FAST FREIGHT					
Elmira to Scranton	1,429	91	00	00	69,164
Elmira to Binghamton	Run as Slow Freight				
PASSENGER MILK & EXPRESS					
Elmira to Scranton via Bing.	2,503	116	00	00	00
" " via New Line	1,773	91	00	00	00

TONNAGE RATING CLASS 3 ENGINE IN M'S

SLOW FREIGHT LOCATION	PRESENT	PROPOSED	DIFF
Elmira to Binghamton	4,560	4,560	00
Binghamton to Hallstead	4,560	4,560	00
Hallstead to Clarks Summit	1,832	4,560	2,728

FAST FREIGHT LOCATION	PRESENT	PROPOSED	DIFF.
Elmira to Binghamton	2,700	2,700	00
Binghamton to Scranton	2,301	2,700	399

WEST BOUND

PRESENT

LOCATION	TRAINS PER YEAR Number	Dist.	LIGHT ENG MILES	LIGHT ENG PUSHER MI	PUSHER MILES
SLOW FREIGHT					
Clarks Summit to Hallstead	7433	40	00	00	7,360
Hallstead to Binghamton	5483	14	00	00	00
Binghamton to Elmira	4,164	57	00	00	3,340
FAST FREIGHT					
Scranton to Binghamton	1,483	61	00	00	6,656
Binghamton to Elmira	855	57	00	00	00
PASSENGER MILK & EXPRESS					
Clarks Summit to Elmira	4,276	111	00	00	00

PROPOSED

LOCATION	TRAINS PER YEAR Number	Dist.	LIGHT ENG MILES	LIGHT ENG PUSHER MI.	PUSHER MILES.
SLOW FREIGHT					
Clarks Summit to Hallstead	2,238	38	00	00	00
Hallstead to Binghamton	1,645	14	00	00	00
Binghamton to Elmira	626	57	6,270	00	00
Clarks Summit to Elmira	3,309	84	00	00	89,343
FAST FREIGHT					
Scranton to Binghamton	445	59	00	00	00
Scranton to Elmira via New Line	711	91	00	00	19,197
PASSENGER MILK & EXPRESS					
Scranton to Elmira via Bing.	2,503	116	00	00	00
" " " via New Line	1,773	91	00	00	00

TONNAGE RATING CLASS 3 ENGINE IN M'S.

SLOW FREIGHT LOCATION	PRESENT	PROPOSED	DIFF
Clarks Summit to Hallstead	2,900	4,560	1,660
Hallstead to Elmira	4,560	4,560	00

FAST FREIGHT LOCATION	PRESENT	PROPOSED	DIFF
Scranton to Binghamton	1,849	2,700	851
Binghamton to Elmira	2,338	2,700	362

NOTE - Proposed Trains Based on 1908 Tonnage — Clarks Summit to Scranton = 7 Miles

TABLE NO. 10.
MARTINS CREEK LINE.
TABLE SHOWING PRESENT & PROPOSED TRAIN MOVEMENT

EASTBOUND

KIND	TRAINS PER YEAR			PRESENT			PROPOSED			LIGHT ENG. Elmira to Bing Miles
	PRESENT	PROPOSED	DIFF	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI.	
Slow Freights	5,[illegible]33	2,303	3,430	121,220	00	00	73,696	00	00	
Fast Freights	2,110	1,798	312	75,152	20,387	23,606	57,536	35,303	26,272	* 18,639
Pass, Milk & Exp.	4,276	4,276	00	32,120	00	00	00	00	00	00
Total	12,119	8,377	3,742	228,492	20,387	23,606	130,232	35,303	26,272	* 18,639

WESTBOUND

KIND	TRAINS PER YEAR			PRESENT			PROPOSED			FAST FRT Binghamton to Elmira
	PRESENT	PROPOSED	DIFF	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI	PUSHER MILES	LIGHT ENG MILES	LIGHT ENG PUSHER MI.	
Slow Freights	7,433	4,727	2,706	7,360	00	00	00	00	00	
Fast Freights	1,483	1,016	467	6,656	00	00	00	00	00	° 327
Pass Milk & Exp.	4,276	4,276	00	00	00	00	00	00	00	
Total	12,192	10,019	3,173	14,016	00	00	00	00	00	° 327

13,192

EASTBOUND

TONNAGE RATING CLASS 3 ENGINE	M'S PER TRAIN		
	PRESENT	PROPOSED	DIFF.
Slow Freights	1832	4560	2728
Fast "	2301	2700	399

WESTBOUND

TONNAGE RATING CLASS 3 ENGINE	M'S PER TRAIN		
	PRESENT	PROPOSED	DIFF.
Slow Freights	2900	4,560	1,660
Fast "	1849	2,700	851

NOTE:-

* Number of Light Engine Miles Saved
° Number of Trains Saved
Proposed Trains Based on 1908 Tonnage

TABLE-NO.11

TABLE SHOWING PER CENT OF INCREASE & DECREASE IN COST PER TRAIN MILE.

1899 - 1908

YEAR	FREIGHT TRAIN MILES	PASSENG. TRAIN MILES	TOTAL TRAIN MILES	COST OF MAINTENANCE & OPERATION.	COST PER TRAIN MILE	PER CENT OF	
						INCREASE	DECREASE
1899	No Complete	Record for	the Year.	$11,406,474.44			
1900	6,129,997	5,423,002	11,552,999	13,426,521.10	$1.161		
1901	6,251,239	5,678,053	11,929,292	13,232,923.33	1.109		4.5
1902	5,047,850	5,119,262	10,167,112	13,248,303.18	1.303	17.5	
1903	6,690,952	5,262,654	11,953,606	14,705,939.68	1.230		5.6
1904	6,510,621	5,414,862	11,925,483	15,302,154.49	1.283	4.3	
1905	6,808,438	5,484,514	12,292,952	17,328,314.46	1.409	9.7	
1906	6,775,916	5,630,425	12,406,341	18,351,049.93	1.479	4.9	
1907	7,529,681	5,681,705	13,211,386	20,960,274.79	1.586	7.2	
1908	6,784,035	5,732,804	12,516,839	17,973,138.82	1.436		9.4

Average Yearly Increase in Cost of Operation - 5.4%
Increase of 1908 over 1900 = 23.6%
Increase of 1908 over 1903 = 8.6%

TABLE NO. 12

TABLE SHOWING SAVING OF PROPOSED LINES OVER PRESENT LINE

BASED ON 5 & 10 YEAR INCREASE IN BUSINESS

FIVE YEAR INCREASE					
CLASS	SHORT LINE	TUNKHANNOCK LINE	NICHOLS LINE	BING-CLARK SUMMIT LINE	MARTINS CR LINE
LENGTH	23.8 Mi.	37.7 Mi.	60.00 Mi.		35.8 Mi.
REDUCTION OF GRADES	226,223.12	226,223.12			240,323.18
ELIMINATION OF — DISTANCE MILES	3.4 Mi.	4.7 Mi.	27.0 Mi.	2.0 Mi.	3.6 Mi.
AMOUNT SAVED	88,254.85	122,359.24			92,680.61
CURVATURE	2459°	2442°	2933°	1003°	2179°
AMOUNT SAVED	77,226.34	76,395.97			67,261.67
RISE & FALL "B"	653	3	920	274	128
" " " "C"	951	951	951	364	951
AMOUNT SAVED	38,479.54	48,502.38			46,497.80
PUSHER MILES	57,487.20	69,677.22			73,211.52
BINGHAMTON TO ELMIRA Fast Freight	14,100.66	14,100.16	00	00	11,597.40
HALLSTEAD YARD	29,499.30	29,499.30	00	20,694.51	29,499.30
NET TOTAL — SAVINGS	386,797.33	557,258.59			519,975.38
CAPITALIZED AT 4%	9,669,933.25	13,931,464.75			12,999,384.50
ESTIMATED COST OF CONST.	7,614,691.00	10,506,073.58	28,092,602.21		11,146,602.75
ALLOWABLE CREDIT	1,489,469.70	780,469.00	579,572.00		1,905,900.40
NET COST	6,125,221.30	9,725,604.58	27,513,030.21		9,240,702.35
NET SAVINGS Capitalized	3,544,711.95	4,205,860.17			3,758,682.15

NOTE Net Saving per Annum would be the interest at 4% on amount shown in last line

TEN YEAR INCREASE					
CLASS	SHORT LINE	TUNKHANNOCK LINE	NICHOLS LINE	BING-CLARK SUMMIT LINE	MARTINS CR LINE
LENGTH	23.8 Mi.	37.7 Mi.	60.00 Mi.		35.8 Mi.
REDUCTION OF GRADES	323,038.50	323,038.50	168,264.00	66,429.00	323,038.50
ELIMINATION OF — DISTANCE MILES	3.4 Mi.	4.7 Mi.	27.0 Mi.	2.0 Mi.	3.6 Mi.
AMOUNT SAVED	126,619.55	175,549.23	572,154.03	40,709.52	132,969.20
CURVATURE	2459°	2442°	2933°	1003°	2179°
AMOUNT SAVED	110,860.65	109,668.60	72,702.79	24,685.56	96,556.05
RISE & FALL "B"	653	3	920	274	128
" " " "C"	951	951	951	364	951
AMOUNT SAVED	57,427.11	71,557.62	24,478.49	11,706.83	58,731.53
PUSHER MILES	81,159.28	98,367.38	31,216.14	—	103,356.57
BINGHAMTON TO ELMIRA Fast Freight	20,135.25	20,135.25	—	—	20,135.25
HALLSTEAD YARD	29,499.30	29,499.30	00	20,694.51	29,499.30
NET TOTAL — SAVINGS	556,921.78	798,316.58	949,914.08		744,787.10
CAPITALIZED AT 4%	13,923,044.50	19,957,914.50	23,747,852.00		18,619,677.50
ESTIMATED COST OF CONST.	7,614,691.00	10,506,073.58	28,092,602.21		11,146,602.75
ALLOWABLE CREDIT	1,489,462.70	780,469.00	579,572.00		1,905,900.40
NET COST	6,125,221.30	9,725,604.58	27,513,030.21		9,240,702.35
NET SAVINGS Capitalized	7,797,823.20	10,232,309.92	3,765,178.21		9,378,975.15

NOTE:- Net Saving per Annum would be the interest at 4% on amount shown in last line

TABLE-NO. 13

ESTIMATED SAVING OF SHORT LINE OVER PRESENT LINE ON 1908 TRAFFIC

SAVINGS DUE TO GRADE	$
Slow Freight 6136 x 41 x 4851	122,039.52
Fast Freight 779 x 61 x 4851	23,051.47
Fast Freight 327 x 57 x 4851 Binghamton to Elmira	9,041.78
DISTANCE	
18396 x 3.39 x 9155	57,092.81
CURVATURE	
18396 x 9.3 x 2912	49,819.31
RISE AND FALL	
Class C 18396 x 475 x 09463 divided by 26.4 = 31,321.46	
Class B 18396 x 326 x 028 " " 26.4 = 6,360.55	24,960.91
PUSHER MILES SAVED	
18639 x 3993 Light Engines Miles Binghamton to Elmira	7,442.55
Savings due to elimination of Hallstead Yard	29,499.30
	322,947.65
PUSHER MILES LOSS	
111,033 x 3993	44,335.48
Total Savings	278,612.17
Savings Capitalized at 4%	6,965,304.25
Est. Cost of Const. Less credits	6,125,221.30
Net Gain	$840,082.95
ESTIMATED SAVINGS ON A FIVE YEAR INCREASE OF TRAFFIC	
SAVINGS DUE TO GRADE	
Slow Freight 7486 x 41 x 62	190,294.12
Fast Freight 950 x 61 x 62	35,929.00
Fast Freight 399 x 57 x 62 Binghamton to Elmira	14,100.66
DISTANCE	
22443 x 3 x 116	78,101.64
22443 x .39 x 116	10,153.21
CURVATURE	
22443 x 9.3 x 37	77,226.36
RISE AND FALL	
Class C 22443 x 475 x 12 ÷ 26.4 = 48,456.47	
Class B 22443 x 326 x 036 ÷ 26.4 = 9,976.93	38,479.54
	444,284.53
PUSHER MILES SAVED	
22,740 x 51 = 11,597.40 = Gain	
135,460 x 51 = 69,084.60 = Loss — Loss	57,487.20
	386,797.33
Savings Capitalized at 4%	9,669,933.25
Est Cost of Const Less Credits	6,125,221.30
Net Gain	$3,544,711.95
ESTIMATED SAVINGS ON A TEN YEAR INCREASE OF TRAFFIC	
SAVINGS DUE TO GRADE	
Slow Freight 8836 x 41 x 75	271,707.00
Fast Freight 1122 x 61 x 75	51,331.50
Fast Freight 471 x 57 x 75 Binghamton to Elmira	20,135.25
DISTANCE	
26490 x 3 x 1.41	112,052.70
26490 x .39 x 1.41	14,566.85
CURVATURE	
26490 x 9.5 x 45	110,860.65
RISE AND FALL	
26490 x 475 x 15 ÷ 26.4 = 71,492.90	
26490 x 326 x 043 ÷ 26.4 = 14,065.79	57,427.11
PUSHER MILES	638,081.06
26840 x 61 = 16,372.40 = Gain	
159,888 x 61 = 97,531.68 = Loss — Loss	81,159.28
Total Savings	556,921.78
Savings Capitalized at 4%	13,923,044.50
Estimated Cost of Const.	6,125,221.30
Net Gain	$7,797,823.20

TABLE NO. 14

ESTIMATED SAVINGS OF TUNKHANNOCK LINE OVER PRESENT LINE: ON 1908 TRAFFIC

SAVINGS DUE TO GRADE	
Slow Freight 6136 x 41 x .485	$122 039.52
Fast Freight 779 x 61 x .4851	23 05 47
Fast Freight 327 x 57 x .4851 Binghamton to Elmira	9 041.78
DISTANCE	
18396 x 47 x .9155	79.155.23
CURVATURE	
18396 x 92 x .2912	49,283.62
RISE AND FALL	
18396 x 475 x .09463 divided by 26.4	31.321.45
18396 x 1.5 x .028 " 26.4	29.27
PUSHER MILES	
111,985 x .3993	44,715.61
Saving due to elimination of Hallstead Yard	29,499.30
Total Savings	388,137.25
Savings Capitalized at 4%	9,703.431.25
Est. Cost of Const. Less Credits	9,725,604.58
Net Loss	$ 22,173.33

ESTIMATED SAVINGS ON A FIVE YEAR INCREASE OF TRAFFIC

SAVINGS DUE TO GRADE	
Slow Freight 7486 x 41 x .62	190,294.12
Fast Freight 950 x 61 x .62	35,929.00
Fast Freight 399 x 57 x .62 Binghamton to Elmira	14,100.66
DISTANCE	
22443 x 47 x 6	122,359.24
CURVATURE	
22443 x 92 x .37	76,395.97
RISE AND FALL	
22443 x 475 x divided by 26.4 =	48,456.47
22443 x 1.5 x .036 " 26.4	45.91
PUSHER MILES	
136,622 x .51	69,677.22
Total Savings	557,258.59
Savings Capitalized at 4%	13,931,464.75
Est Cost of Const. Less Credits	9,725,604.58
Net Gain	$4,205,860.17

ESTIMATED SAVINGS ON A TEN YEAR INCREASE OF TRAFFIC

SAVINGS DUE TO GRADE	
Slow Freight 8836 x 41 x .75	271,707.00
Fast Freight 1122 x 61 x .75	51,331.50
Fast Freight 471 x 57 x .75 Binghamton to Elmira	20,135.25
DISTANCE	
26490 x 47 x 1.41	175,549.23
CURVATURE	
26490 x 9.2 x .45	109,668.60
RISE AND FALL	
26490 x 475 x .15 divided by 26.4	71,492.90
26490 x 1.5 x .043 " " 26.4	64.72
PUSHER MILES	
161,258 x .61	98,367.38
Total Savings	798,316.58
Savings Capitalized at 4%	19,957,914.50
Est. of Cost of Const. Less Credits	9,725,604.58
Net Gain	$10,232,309.92

TABLE NO. 15

ESTIMATED SAVING OF NICKOLS LINE OVER PRESENT LINE ON 1908 TRAFFIC

SAVINGS DUE TO GRADE		
Slow Freight 3800 x 41 x .4851		$75,578.58
Fast Freight 1008 x 61 x .4851		29,827.63
DISTANCE		
10025 x 2 x .9155		18,355.77
10437 x 27 x .9155		257,986.98
CURVATURE		
10025 x 3.8 x .2912		11,093.26
10437 x 1.075 x .2912		32,671.98
RISE AND FALL		
Class C 10437 x 475 x .09463 divided by 26.4	7,770.28	
Class C 10025 x 182 x .09463 " 26.4	6,540.04	
	24,310.32	
Class B 10437 x 657 x .028 divided by 26.4 =	7,272.69	
Class B 10025 x 137 x .028 " " 26.4 =	1,456.66	
	8,729.35	15,580.97
Savings due to elimination of Hallstead Yard		0,694.51
		567,195.89
PUSHER MILES LOSS		
19088 x .3993 Light Engine Miles		7,621.84
11159 x .3993 " " (Pushing)		4,455.79
5290 x .3993 Pusher Miles		2,112.30
		14,189.93
Savings		567,195.89
Loss		14,189.93
Total Savings		553,005.96
Savings Capitalized at 4%		13,825,149.00
Est. Cost of Const. Less Credits		27,513,030.21
Net Loss		$13,687,881.21
ESTIMATED SAVINGS ON A TEN YEAR INCREASE OF TRAFFIC		
SAVINGS DUE TO GRADE		
Slow Freight 5472 x 41 x .75		168,264.00
Fast Freight 1452 x 61 x .75		66,429.00
DISTANCE		
14436 x 2 x 1.41		40,709.52
15029 x 27 x 1.41		572,154.03
CURVATURE		
14436 x 3.8 x .45		24,685.56
15029 x 10.75 x .45		72,702.79
RISE AND FALL		
Class C 15029 x 475 x .15 divided by 26.4 =	40,561.22	
Class C 14436 x 182 x .15 " " 26.4	14,928.14	
	55,489.36	
Class B 15029 x 657 x .043 " " 26.4	16,082.73	
Class B 14436 x 137 x .043 " " 26.4 =	3,221.31	36,185.32
	19,304.04	981,130.22
PUSHER MILES LOSS		
27487 x .61 Light Engine Miles		16,767.07
16069 x .61 " " " (Pushing)		9,802.09
7618 x .61 Pusher Miles		4,646.98
		31,216.14
Savings		981,130.22
Loss		31,216.14
Total Savings		949,914.08
Savings Capitalized at 4%		23,747,852.00
Est. of Cost of Const. Less Credits		27,513,030.21
Net Loss		$3,765,178.21

TABLE NO. 16

ESTIMATED SAVING OF MARTINS CR. LINE OVER PRESENT LINE ON 1908 TRAFFIC

SAVINGS DUE TO GRADE	
Slow Freight 6136 x 41 x .4851	$122,039.52
Fast Freight 779 x 61 x .4851	23,051.47
Fast Freight 327 x 57 x .4851 Binghamton to Elmira	9,041.78
DISTANCE	
18396 x 3.56 x .9155	59,955.88
CURVATURE	
18396 x 8.1 x .2912	43,391.01
RISE AND FALL	
18396 x 475 x .09463 divided by 26.4 = 31,321.45	
18396 x 64 x .028 " " 26.4 = 1,248.69	30,072.76
PUSHER MILES	
99026 x .3993	39,541.08
18639 x .3993 Light Engines Binghamton to Elmira	7,442.55
Savings due to Hallstead Yard	29,499.30
Total Savings	364,035.35
Savings Capitalized at 4%	9,100,883.75
Est Cost of Const. Less Credits	9,240,702.35
Net Loss	$139,818.60
ESTIMATED SAVINGS ON A FIVE YEAR INCREASE OF TRAFFIC	
SAVINGS DUE TO GRADE	
Slow Freight 7486 x 41 x .62	190,294.12
Fast Freight 950 x 61 x .62	35,929.00
Fast Freight 399 x 57 x .62	14,100.66
DISTANCE	
22443 x 3.56 x 1.16	92,680.61
CURVATURE	
22443 x 8.1 x .37	67,261.67
RISE AND FALL	
22443 x 475 x .12 divided by 26.4 = 48,456.47	
22443 x 64 x .036 " " 26.4 = 1,958.67	46,497.80
PUSHER MILES	
120812 x .51	61,614.12
22740 x .51 Light Engines Binghamton to Elmira	11,597.40
Total Savings	519,975.38
Savings Capitalized at 4%	12,999,384.50
Est. Cost of Const. Less Credits	9,240,702.35
Net Gain	$3,758,682.15
ESTIMATED SAVINGS ON A TEN YEAR INCREASE OF TRAFFIC	
SAVINGS DUE TO GRADE	
Slow Freight 8836 x 41 x .75	271,707.00
Fast Freight 1122 x 61 x .75	51,331.50
Fast Freight 471 x 57 x .75 Binghamton to Elmira	20,135.25
DISTANCE	
26490 x 3.56 x 1.41	132,969.20
CURVATURE	
26490 x 8.1 x .45	96,556.05
RISE AND FALL	
26490 x 475 x .15 divided by 26.4 = 71,492.90	
26490 x 64 x .043 " " 26.4 = 2,761.37	68,731.53
PUSHER MILES	
142,597 x .61	86,984.17
26,840 x .61 Light Engines Binghamton to Elmira	16,372.40
Total Savings	744,787.10
Savings Capitalized at 4%	18,619,677.50
Est Cost of Const. Less Credits	9,240,702.35
Net Gain	$9,378,975.15